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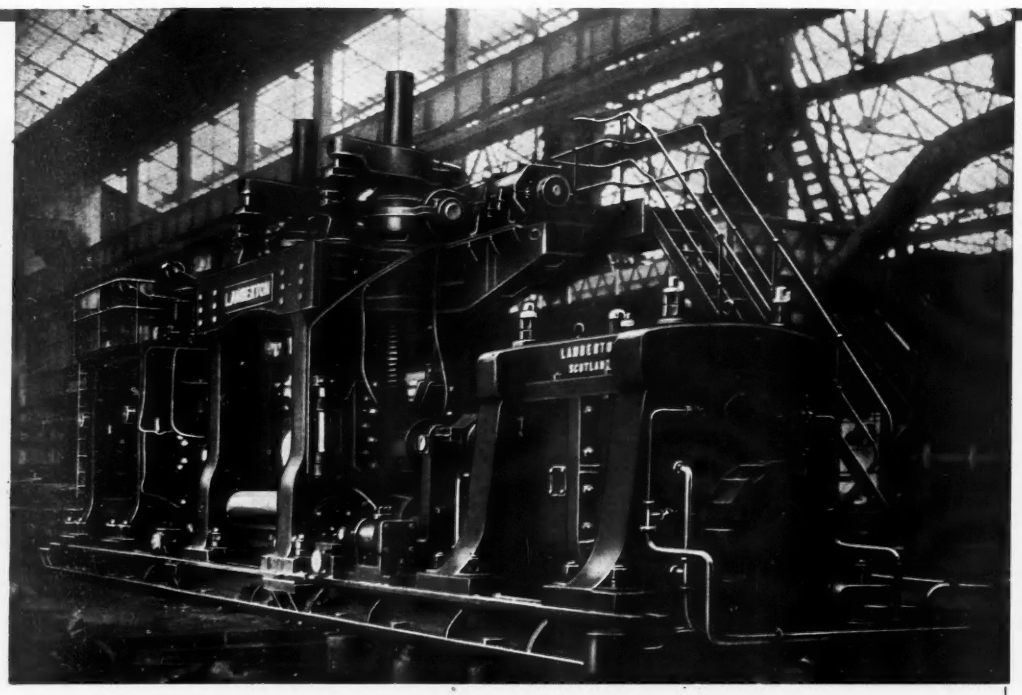

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Port of London Authority Report

The thirty-first annual report of the Port of London Authority has just been presented to the Minister of Transport. The financial statement of the Authority which accompanies the report shows that the working balance over total revenue is £1,558,137. The expenditure during the year on account of the general fund for the maintenance and renewal of premises and plant, and for dredging, was £73,261, and after transferring £100,000 from the net revenue account for the current year in respect of normal renewals and replacements, and providing £225,000 to meet expenditure on maintenance, renewals, and dredging postponed in consequence of the war, the balance standing to the credit of the fund at March 31st, 1940, was £527,585. Works completed during the year, which are mentioned in the report, include the electrification of a berth, the installation of a 750-kW converter, and the construction of a new warehouse at Surrey Commercial Docks. For the river, two new oil-engine-driven launches for harbour service have been completed and commissioned, and a small dredger and three hopper barges have been purchased for work on the Surrey Canal and the upper reaches of the river. During the year new electric quay cranes have been delivered, and five of the bridges connected with the L.C.C. programme of road construction have been reconstructed and one is nearing completion. Ten bridges are to be dealt with under this scheme.

The Institute of Fuel

At a meeting of the Institute of Fuel, which took place on Thursday afternoon at the Connaught Rooms, an address was delivered to the members by Mr. W. H. Selvey, who in the past few months has been Acting President during Lieut.-Colonel J. H. M. Greenly's absence abroad. He spoke of the wide diversity of interests to be found among the members of the Institute, and said that coal, coke, patent fuel, electric power, town's gas, producer gas, fuel oil, and petrol all had their experts among the membership. Casual acquaintance among members had often ripened into a community of interest, and it was with considerable confidence that he could say, come what might, there would be always a need for that common ground of meeting and an Institute to fill the need. Mr. Selvey then went on to speak of scientific invention and its application to the life of a country, and said that it was generally twenty years and often longer before scientific knowledge produced practical applications which entered into the common life of the country. The solution of that problem was, he contended, difficult, but it must be tackled along the lines of education and training for administration. It was a most amazing state of affairs, that in a world that was fast becoming wholly technical, the men having the power and responsibility could almost boast of their ignorance on technical questions. We had, however, to consider deeply that there were countries where the men in power were technically trained as a basis for their future activities, educated to some degree in the scholastic field of knowledge, but totally devoid of morals when acting as functionaries of the State. It was not more difficult to distinguish among young technologists than among classical graduates the men who were likely to develop into administrators. The future might demand for very existence that the early training of men who were called upon to lead should be technological as well as, or more so than, humanistic, because they must function in an almost wholly technological world. Everywhere there was a growing consciousness that something must be changed before it was safe to put further powers evolved by scientists and technologists in the hands of those governing the political fortunes of the State.

The Scrapping of Iron Railings

A recent statement made by the Iron and Steel Control announces that since the "railings for scrap" campaign opened in May, 424 local authorities have relegated 22,000 tons to the steel works. In addition, 547 Councils are now surveying all railings on their property or considering the results in committee. Though the average of 1000 tons a week has almost all come from properties owned by local authorities, privately owned railings have been given at Bolton, Oxford, Glasgow, Newcastle-on-Tyne, and other places. The Office of Works and the Liverpool Corporation have each given over 1000 tons, and Birkenhead, Birmingham, Bolton, Manchester, and Oxford over 600 tons. In Manchester a profit of £896 has been made from the sale of the railings from twenty-five parks. Before privately owned railings can be taken, permission must be received from all interested, ground landlords, leaseholders, and tenants. Acquisition becomes correspondingly more difficult in areas where there are numerous small landlords and tenants. Already good progress has been made in this direction in Oxford and on one or two London estates. Another source of scrap has been old guns, which have been utilised as bollards by being set muzzle upwards in the ground. Examples of such bollards are to be found on Woolwich Common and at the Tower of London. Up to date, some 800 to 900 tons of such guns, including many imitation guns, hollow, and only about ¼in. in thickness, have been recovered, and have been collected from Hyde Park and Rotten Row for use as scrap. Mr. James Melvin, A.R.I.B.A., an officer of the Iron and Steel Control, is working in close collaboration with the Georgian Group in exempting from the condemning as scrap of any ironwork of real distinction.

British Export Trade

In a speech made at the Lincoln Chamber of Commerce luncheon on Monday last, October 14th, Sir Cecil Weir, an executive member of the Export Council of the Board of Trade, stressed the importance of export trade, and pointed out the opportunities which at the present time lie in front of exporting firms. Sir Cecil recalled that although we had lost many markets, by April last, our export figures had then reached a value which had not been equalled during the last ten years. That, he said, was a tribute to the strength and flexibility of our industrial economy, to the enterprise of our manufacturers and exporters, and, above all, to the courage, heroism, and resource of our naval and merchant seamen and commanders. One of our most pressing problems to-day was that of a policy with regard to surpluses, which was alike vital to ourselves, the United States, and the Dominions, and must be considered. Speaking to exporters, he said that they could now capture some of the trade of the enemy. In the meantime, they could provide the goods which invaded countries had formerly sold. In the consumer goods industries the raw materials for export trade were in most cases plentiful. It was true that our chances of doing business abroad might be said to have suffered to some extent from the bombing to which our industrial districts were being subjected, but in many cases the loss had been far less than might have been expected. There was no need for buyers to have any doubt about our ability to make, sell, and deliver the goods which they wanted.

An L.M.S. Express Derailment

We have to record a serious derailment of the L.M.S. Liverpool to Euston express as it was approaching London on Saturday last. Nine persons were killed, including the driver and the fireman of the train, and a number of passengers were seriously injured. As the express was passing through a station a luggage trolley got out of control and ran down the platform ramp. It fell on the rails in front of the oncoming express, and, although the driver tried to reduce the speed of the train, it was caught and was carried along the track until it became wedged in the rail points. The front part of the train was derailed, the engine turning over and burying its nose in the track, while the tender was thrown over and turned on its side. Some of the coaches piled themselves on the top of the engine and were overturned and smashed. The track was destroyed for about 50 yards, rails being torn from the track and hurled through the carriage windows, while carriage doors were ripped off. A water column on the side of the track was damaged. A number of passengers were trapped in the carriages, but the railway staff, which was assisted by A.R.P. and other workers, immediately came to their aid. While the work of rescue was proceeding an air raid took place, but the work went on without interruption. Soon after the accident the work of removing the wreckage and restoring the line was begun. The blocked lines were again in operation on Monday.

A Proposed Transport Council

In an address delivered to the Institute of Transport on Monday, October 14th, Mr. Frederick Smith, a member of the Council of the Institute, advocated a full-time Transport Council, as part of the Ministry of Transport. The period of reconstruction after the war would, he said, present many problems. Those problems would be simplified if necessary reforms were to be made during the war. They would have to be made now if the difficulties of last winter were to be mitigated. Mr. Smith then went on to say that, in his opinion, transport policy should be so developed as to open the way for a system of planning, which, while preserving to the public all forms of transport, would injure none, would be equitable, and would provide the framework round which could be built a completely reconstructed national economy, designed to repair the ravages of war, and to lay the foundations of a better world. In this connection Mr. Smith stated that he considered that the next stage in the development of the Ministry of Transport should follow as closely as possible the organisation of the Admiralty and the Air Ministry, &c. The Ministry of Transport should be assisted by a full-time Transport Council analogous to the Board of Admiralty, the Air Council, and the Army Council. The Council should consist, in addition to the Permanent Secretary to the Ministry, of professional transport officers, experienced in different branches of the profession, but severing their connections with individual interests, and becoming full-time servants of the State. There was, he considered, a most urgent need, even for war purposes only, for the establishment of such a general staff.

Employment Returns

It was officially announced by the Ministry of Labour and National Service on Monday, October 14th, that the number of persons who were wholly unemployed at September 16th was approximately the same as at August 12th, being 613,671 at the former date, as compared with 613,156 at the latter date. At September 16th there were 185,000 workers on short time, or otherwise temporarily suspended from work on that date, on the understanding that they were shortly to return to their former employment, an increase of 30,620 as compared with August 12th. The number of unemployed casual workers on the register, being persons who normally seek their livelihood by jobs of short duration, was slightly less at September 16th than at August 12th. It was 31,175 at the former, and 31,916 at the latter date. The only industry in which there was any considerable increase in unemployment was coal-mining. An analysis of the number of unemployed shows that included in the total of 829,846 on the registers at September 16th there were 318,234 men wholly unemployed and 97,548 temporarily stopped, these men being normally in regular employment. There were 29,486 unemployed men who are normally in casual employment. Similar figures for boys are 25,145 wholly unemployed, 3056 temporarily stopped, and 110 in casual employment; for women, the figures are 227,293, 78,995, and 1561, and for girls, 42,999, 5401, and 18. Within the interval between August 12th, 1940, and September 16th, 1940, the total numbers of unemployed shown on the registers of the various administrative divisions indicate decreases in employment in the London, Eastern, Southern, South-Western, North Midlands, Northern, and Wales areas, and increases in employment in the North-Eastern, North-Western, and Scotland areas.

Mr. Ernest Bevin's Appeal

On Wednesday, October 9th, Mr. Ernest Bevin, the Minister of Labour, addressed the Trades Union Congress at Southport, and made a striking appeal to labour to carry on the war to a victorious end. Speaking on behalf of the Government, he said that the issue was so grave that the future of our liberty was at stake, and that the Government could not tolerate any one devising plans or pursuing machinations which held up the production of armaments. In that, he said, he believed he had the full support of the trade unions. In the course of his speech Mr. Bevin referred to a close arrangement between the Ministry of Labour and the Foreign Office, with a view to placing that service in a new environment. Turning to home matters, he said that the Cabinet was not unmindful of the problem of post-war needs and that a Cabinet Committee had been formed to deal with those matters. With regard to immediate problems, he said that although he had invented the idea of roof spotters, he would welcome any better scheme. He asked all works managers in conjunction with trade union representatives to examine the matter closely. With regard to factory work, Mr. Bevin said that he had indicated to the Cabinet that he would have to make canteens compulsory in works which employed more than a certain number of persons. That would come before the Factory Welfare Board at its next meeting. With regard to sickness among workers, he announced that the whole of the emergency hospital arrangements had been opened to munition workers equally with the troops. After making reference to probable events in Russia and China, Mr. Bevin concluded his address by asking Congress to appreciate the vigil of our great Navy. Errors of judgment would be made, he continued, but they would be acknowledged and not hid from the people. That, he considered, was the only way democracy could be kept healthy, clean, and incorruptible. He believed that the people would understand and he appealed to them, whatever difficulties had to be overcome, to go forward as a great industrial army in this terrible total war, so that at the end of it it should be said that Labour, by its skill, its craft, its courage, its devotion, had saved a great people.

The Pressure of Earth Against Lateral Supports

By R. R. MINIKIN

IN recent years many eminent professors and engineers have given a good deal of attention to theories of earth pressure against lateral supports. Names such as Resal, Teizaghi, Casagrande, McCormack, Feld, and latterly Jenkins, show that the subject has importance as well as academical interest.

However, in spite of the thorough and erudite treatment of the subject by these authorities of modern engineering problems, the revised wedge theory has not yet entirely displaced reliance on the older formulæ of Coulomb and Rankine. Even in the offices where the wedge theory is applied direct or in the form of Rebhann's graphic construction, the results more often than not are checked by Rankine's formulæ. This attitude

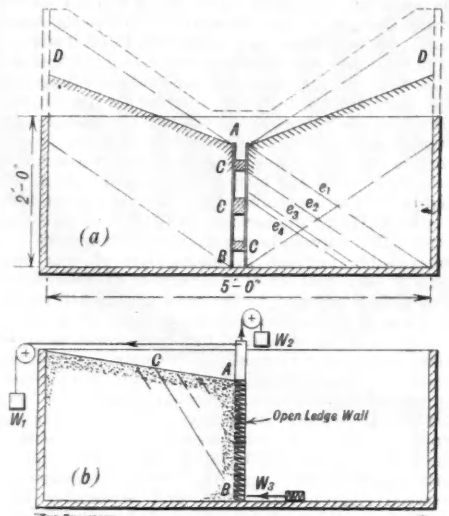
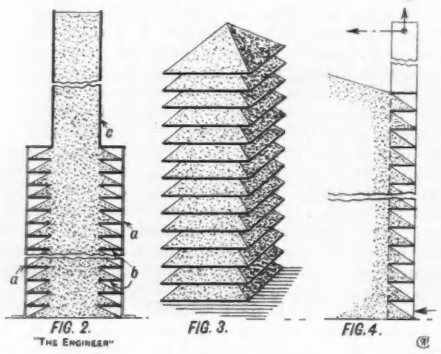


FIG. 1—TEST APPARATUS

of engineers generally is due for the greater part to doubt concerning the applicability of formulæ based upon experiments with miniature apparatus under strictly laboratory conditions and an involved academical analysis.

Having had for several decades much to do with earthworks, the author decided to experiment on a more generous scale with simple apparatus and to cut out any preconceived notions and theories, obtain the data, and interpret the results in simple direct engineer fashion. After many months of trial the author at last devised a simple apparatus which fulfilled the elementary conditions of the test.

As shown in Fig. 1 (*a*) it was contained in a



TESTS FOR DISTRIBUTION OF PRESSURE

rectangular box 5ft. by 2ft. by 1ft. 6in. wide, with plate glass sides and timber bulkheads capable of extension with wind sides D for surcharge. To measure the pressure of the sand a novel form of pressure gauge A B was used. Two plates of plywood with chamfered edges just fitting the box sandwiched small sponge rubber discs C. This sponge rubber sandwich was first calibrated by direct means in many different forms, and after each trial was again tested to reproduce form under load. Under stress the distance apart of the plates was measured by using internal calipers at nine points, viz., corners, middle of edges, and centre. Several such plates of varying heights were used. The sponge rubber was preferred to steel springs, which, when subjected to uneven loading, tended to distort the relative positions of the plates.

To obtain static conditions as closely as possible the sand was poured in very slowly and gently on both sides simultaneously of the plates A B to form heaps of equal dimensions on each side. The time taken for continuous loading to the required height was seldom less than two hours. Occasionally, intervals of twenty-four hours occurred from half full state to complete loading.

Meantime, measurements of the compression of the plates and the angle of repose were taken. It was found that the slightest disturbance or a too rapid loading destroyed the static condition of the sand, and when such happened the apparatus was emptied and refilled. On completion of the filling and the recording of observations the bench

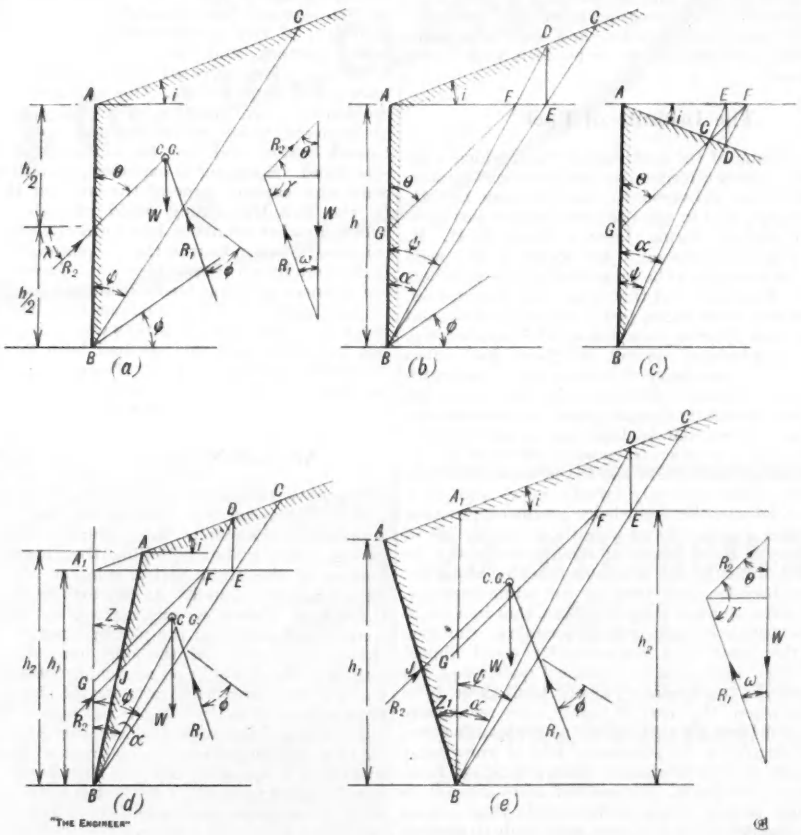


FIG. 5

slight amount of sand was withdrawn from the toe of the slope and the mechanism again operated, and so on, until a definite sign of rupture was registered.

Just at the moment of rupture several small cracks appeared in the top surface until a definite slump occurred in one indicating the top of the actual slipping wedge; but this is not the apex C of the rupture plane shown in Fig. 5. The actual rupture surface is slightly curved in plan across the box and is not a true straight plane as it is represented for convenience of expression in the diagrams. The angle of rupture ψ not only varies slightly for the same material under similar dimensional conditions, but shows considerable variation with changes in the slope of the surface i. The point C in the diagrams represents approximately the average registration of the position where the rupture surface cuts the top surface assuming the rupture surface to be a true plane.

The pressure readings near the point of collapse were difficult to obtain as the delicate balance of the system was too easily disturbed; nevertheless, the fact was definitely established that the centre of pressure was between 0·48 and 0·51 of the height above the base. This indicated that the pressure distribution varied in equal manner above and below the centre of the plates. For a horizontal top surface the critical plane on which the apparatus rested was tapped lightly with a hammer. This had the effect of increasing the pressure on the plates and varied in amount with the slope of the top surface. The most important effect, however, was to heighten the centre of pressure above the base. With the sand in the loose static state the centre of pressure on the average of hundreds of readings was at 0·44 of the height of the plates, but the slight consolidation caused by the vibration increased this to 0·48.

The third part of the test was then undertaken to approximate to conditions of collapse under purely natural forces. In the right compartment of Fig. 1*a* the sand was allowed to trickle out slowly until the angle of repose was coincident with the base of the box as shown by the upper line e_1, sloping downwards to the right. Thereafter the sand at the toe was gently raked away, causing the sand in the right compartment to assume the diminished heaps marked e_2, e_3 e_4. Meanwhile, the plates were closely observed until the very slightest movement of the left plate indicated that slip was imminent. An unbalanced vibratory mechanism was then placed on a board resting on the top edges of the glass sides of the box and set in motion. If no movement of the plates took place with this vibratory incentive a further of rupture was approximately at $\frac{1}{2}(90-\varphi)$ from the vertical, but with a positively sloping top surface this angle increased considerably, and with a negative sloping surface decreased.

To test the distribution of pressure further various devices were employed. In the first annular tin discs *b*, 3½in. outside and 2in. inside diameter were built up on four slender verticals *a*, as shown in Fig. 2. The centre core was carefully filled with sand. When full to the top plate all spilled sand was gently cleaned away and the edges of sand registered at each vertical. The funnel extension C was then placed and slowly filled, but no change could be observed in the registered positions of the sand verges.

In the second trial thin metal plates, 5in. square, were procured and carefully built up in stages as shown in Fig. 3, each plate being placed successively on a small sand heap immediately below. There was no precise levelling, all being set by eye. At the height of 10in. a ½ lb. weight was placed on top. There was a slight reduction of height due to the compaction under the weight, but on increasing the weight to 1½ lb. no further alteration of height was observed nor yet any alteration of the individual sand slopes.

It was assumed from these experiments that within practical limits there is no lateral flow of sand

under pressure provided the free surface lies at the angle of repose. A thin metal wall was then made, as shown in Fig. 4. This wall consisted of a series of very thin horizontal ledges full across the width of the box, offering no direct lateral resistance excepting the chamfered edges of the metal. The thin vertical supports, one at each end and one central, were filed to a knife-edge on the inside. Projections at the toes of the verticals pressed against small steel springs W_3, Fig. 1 (*b*), and the tops were held by weighted strings W_1 passing over pulleys. The wall was held rigidly in position whilst filling the sand to the required height.

Trial weights, slightly greater than anticipated, were placed in the pans W_1 and the securing thumbscrews eased to allow the wall to take its natural position. The weights in the pans W_1 were then gradually reduced to bring the wall truly vertical and equilibrium was established as critically as the apparatus would allow. The spill of the sand on each ledge was then gently scraped away from the toe of each so that the minimum remained. Whilst no definite measurement of variation was possible it appeared that the sand on the ledges was more live at the centre half.

In these tests the readings of the weights and springs gave the centre of pressure as being at 0·57 of the height above the base. This was apparently due to the friction of the wall on the base relieving the springs W_3 of a portion of the horizontal thrust, as when the wall was slightly raised by external means a greater pressure was registered which lowered the centre of pressure to 0·49 of the height.

To bring about collapse the apparatus was subjected to the vibrations caused by striking the

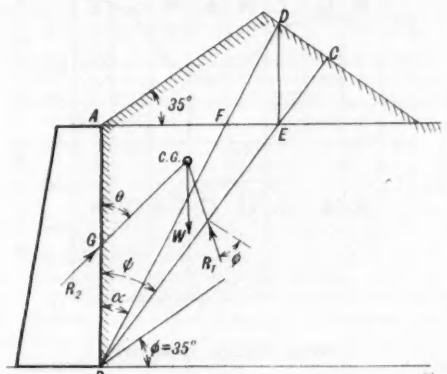


FIG. 6

bench with a mallet. It was noted immediately prior to collapse that shear was most pronounced away from the back of the wall and not at the wall. The slipping wedge adhered to the wall and moved with it until a definite slump occurred. There was little evidence of two planes of rupture. The slip down the back of the wall only occurred in complete collapse, and not at the failing moment.

Arising from this test a further refinement was introduced by adding the weighted pans W_2, shown in Fig. 1 (*b*), to take the vertical load on the wall. As the balance was extremely delicate at the critical moment, the pulley strings were raked slightly backward, actually 1 deg. This was to ensure that there was no tendency to pull the wall away from the sand and cause premature collapse. The pans W_2 were weighted gently by small increments until movement of the sand grains at the toe of the wall showed that the full vertical load was taken. The results from this addition showed that the downward pressure on the wall was definitely greater than that due to the usually accepted angle of repose (friction) to the normal to the wall; in other words, the resultant of the forces W_1, W_2, and W_3, sloped at an angle greater than φ to the normal to the wall.

From the tabulated and graph results of observations, it was concluded that:—(1) Under entirely undisturbed static conditions the horizontal pressure on the vertical wall is uniform from top to bottom, and is of considerably less value than in a state bordering on shear failure. (2) The line of the resultant force cuts the back of the vertical wall at half the height and passes through the centre of gravity of the slipping wedge. (3) The slipping wedge at the moment of failure is potentially integral with the back of the wall; in other words, they move together as if the wedge were of solid material and pressing close up against the wall. (4) There is an arch action between the surface of rupture and the back of the wall, which tends to relieve the pressure at the foot. (5) Over the middle portion of the wall the pressure is uniform, tapering off to zero at the top of the wall, due to decrease in the shear resistance of the free sand, and tapering off in a similar manner to zero at the heel of the wall due to the arch action above mentioned. (6) The plane of rupture in sand with a horizontal surface makes an angle approximately $\frac{1}{2}(90-\varphi)$ to the vertical through the heel of the wall. This angle increases with an increase in the slope of the surface of the sand to the horizontal and decreases with a negative inclination of the top surface. (7) The effective inclination of the resultant force, due to earth pressure, to the normal to the back of the vertical wall, is greater than the angle of repose φ; in other words, the vertical component of the thrust on the wall is greater than $R_2 \tan \varphi$, and is $R_2 \tan \lambda$.

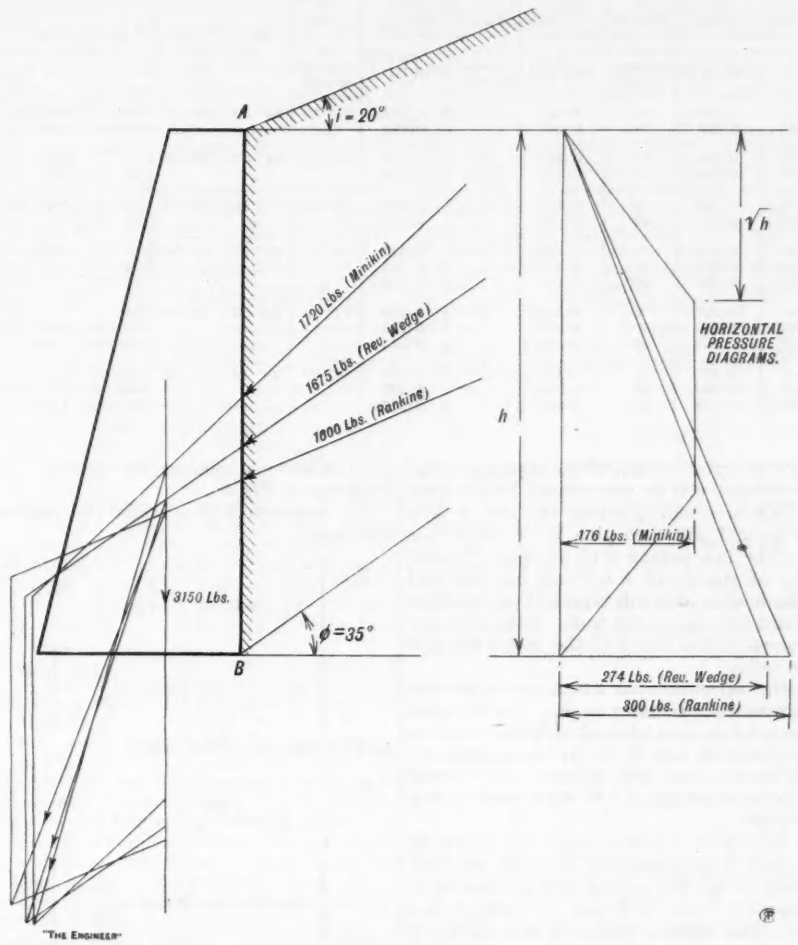


FIG. 7

Symbols Used

Let φ=angle of repose.

$\alpha=\frac{1}{2}(90-\varphi)$ from the vertical through the heel of the wall.

ψ=angle between the vertical through the heel of the wall and the plane of rupture.

θ=angle between the vertical at the heel of the wall and the resultant force on the wall $=90-\lambda$.

λ=effective friction angle between the resultant force and the normal to the vertical wall.

ω=in the vector triangle, the angle that the resultant of the frictional resistance on the plane of rupture makes to the vertical.

γ=the angle between the resultant force on the wall and the resultant force due to friction on the rupture plane.

i=the angle to the horizontal of the top surface of the ground.

w=weight of a cubic foot of sand.

W=weight of slipping wedge of sand, 1ft. thick.

In Fig. 5 (*a*) the back of the wall is shown as A B, with the top surface sloping at angle i to the horizontal. B C is the plane of rupture, which is at an angle ψ to the vertical, where

$$\cot \psi = \cot \alpha - \tan i$$
$$= \cot \tfrac{1}{2}(90-\varphi) - \tan i \quad . \quad . \quad . \quad (1)$$

The slipping wedge is represented by triangle A B C, and the area of A B C is

$$= \frac{h^2}{2} \times \frac{1}{2\left(\frac{1}{2}\cot \alpha - \tan i\right)} \quad . \quad . \quad (2)$$

and the weight of the wedge A B C, 1ft. thick,

$$W = \frac{w h^2}{2} \times \frac{1}{2\left(\frac{1}{2}\cot \alpha - \tan i\right)} \quad . \quad . \quad (3)$$

The line of the resultant force passes through the centre of gravity of the triangle A B C and cuts the back of the wall at $h/2$ above the base, and will, if produced, also cut the top surface at the apex C of the triangle.

The line of force R_2 in the vector triangle therefore makes an angle to the vertical, such that

$$\tan \theta = 2 \tan \alpha = 2 \tan \tfrac{1}{2}(90-\varphi) \quad . \quad . \quad (4)$$

and the force in pressure units is

$$R_2 = W \times \frac{\sin \omega}{\sin \gamma} \quad . \quad . \quad . \quad . \quad . \quad (5)$$

Similarly, the resultant force R_1 on the rupture plane due to the frictional resistance against sliding is

$$R_1 = W \times \frac{\sin \theta}{\sin \gamma} \quad . \quad . \quad . \quad . \quad . \quad (6)$$

where

$$\gamma = 180^\circ - \theta - \omega$$
$$\omega = 90 - \psi - \varphi.$$

Thus the resultant force on the wall acting at the angle $\lambda = 90 - \theta$ to the normal is

$$R_2 = \left[\frac{1}{2\left(\frac{1}{2}\cot \frac{90-\varphi}{2} - \tan i\right)} \times \frac{\sin \omega}{\sin \gamma}\right] \frac{w h^2}{2} \quad . \quad (7)$$
$$= C_m \frac{w h^2}{2}$$

where C_m=the expression in large brackets.

In Table I a comparison is made between the results given by this formula and those of Rankine and the Revised Wedge theory as propounded by Professor Jenkins. It will be noted that the values of the coefficients C_m, C_R, and C_J of the general formula are very close, excepting in the lesser angles of repose. On the whole, the value as given by (7) is slightly greater for the larger angles and less for the smaller; but the difference is not of practical importance. The formula (7) gives results that tend to economise in the weight of retaining walls and follows very closely the results of Professor Jenkins in spite of having been arrived at in a very different and less precise way.

Graphic Construction

In Fig. 5*b* a simple graphical construction is

shown to find the triangle of the wedge of rupture A B C. A B represents the back of the wall. From the vertical through B set off the angle $\alpha=\frac{1}{2}(90-\varphi)$, cutting the top surface in the point D. From D drop a perpendicular to the horizontal through the top of the wall cutting the latter at E. Draw B E to cut the top surface at C. Then in all cases the cross section of the slipping wedge of unit thickness will be represented by the area A B C. This area multiplied by the unit weight w of the ground will then give W of the vector triangle. The line joining F G will pass through the centre of gravity of A B C and cut the wall at half the height, and will represent in direction the resultant force R_2 on the wall. As R_1 acts at φ to the normal to the line B C, the vector triangle is easy to solve.

Where the top surface has a negative inclination to the horizontal as shown in Fig. 5*c*, the same procedure is followed as lettered, with the exception that the points E and F on the horizontal are produced beyond the top surface. The result gives a slipping wedge A B C with angle ψ less than the angle α.

For a wall with negative batter as shown in Fig. 5*d* erect a perpendicular through the heel B and produce the top surface line to cut this in A_1. Construct from A_1 B the triangle A_1 B C as before. The slipping wedge of unit thickness will then be represented by the area A B C. Through the centre of gravity of this area draw a line parallel to F G, cutting the wall in J. This will represent in position and direction the resultant force R_2.

For a wall with positive batter as shown in Fig. 5*e*, the vertical from B will cut the top surface at A_1, which is the virtual height of the wall. Proceed as before to find the triangle A_1 B C. Then the slipping wedge of unit thickness is A B C. Find the centre of gravity of this area and draw a line parallel to F G, cutting the wall in J. Then this line will represent in position and direction the resultant force R_2.

For any shape of top surface the same method of construction applies as, for example, the heaped surcharge in Fig. 6.

For negative batter walls the expression (7) will read :

$$R_2=\left[\frac{1}{2\left(\frac{1}{2}\cot\frac{90-\varphi}{2}-\tan i\right)}\times\frac{\sin\omega}{\sin\gamma}\right]\frac{w\,h_v^2}{2}-\left[(\tan Z-\tan^2 Z\tan i)\frac{\sin\omega}{\sin\gamma}\right]\frac{w\,h^2}{2}$$

and for positive batter walls :

$$R_2=\left[\frac{1}{2\left(\frac{1}{2}\cot\frac{90-\varphi}{2}-\tan i\right)}\times\frac{\sin\omega}{\sin\gamma}\right]\frac{w\,h_v^2}{2}+\left[(\tan Z+\tan^2 Z\tan i)\frac{\sin\omega}{\sin\gamma}\right]\frac{w\,h^2}{2}$$

where h = height of wall.
h_v = virtual height of wall = A_1B.
Z = angle of inclination of the wall to the vertical.

A comparison of the formula (7) with those of Rankine and Jenkins' Revised Wedge is shown in Fig. 7.

TABLE I.—*Comparison of Formulæ*

Angle of repose.	Slope of surface.	Rankines' co-efficient.	Slope of resultant	Rev. wedge co-efficient	Slope of resultant	Minikin co-efficient.	Slope of resultant	θ.	α.	ψ.	γ.	ω.
φ	i.	$C_R\left(\frac{w\,h^2}{2}\right)$	To normal to wall.	$C_J\left(\frac{w\,h^2}{2}\right)$	To normal to wall.	$C_M\left(\frac{w\,h^2}{2}\right)$	To normal to wall.					
20°	0	0·490	0	0·426	20°	0·402	35° 30′	54° 30′	35° 0′	35° 0′	90° 30′	35° 0′
,,	20°	0·939	20°	0·939	,,	0·650	,,	,,	,,	43° 20′	98° 50′	26° 40′
25°	0	0·406	0	0·362	25°	0·345	38° 10′	51° 50′	32° 30′	32° 30′	95° 40′	32° 30′
,,	20°	0·545	20°	0·553	,,	0·522	,,	,,	,,	39° 55′	103° 5′	25° 5′
30°	0	0·333	0	0·297	30°	0·294	40° 50′	49° 10′	30° 0′	30° 0′	100° 50′	30° 0′
,,	20°	0·415	20°	0·424	,,	0·422	,,	,,	,,	36° 10′	107° 0′	23° 50′
35°	0	0·271	0	0·250	35°	0·252	43° 50′	46° 10′	27° 30′	27° 30′	106° 20′	27° 30′
,,	20°	0·320	20°	0·335	,,	0·344	,,	,,	,,	32° 45′	111° 35′	22° 15′
,,	30°	0·445	30°	0·456	,,	0·454	,,	,,	,,	36° 40′	115° 30′	18° 20′
40°	0	0·217	0	0·210	40°	0·212	47° 0′	43° 0′	25° 0′	25° 0′	112° 0′	25° 0′
,,	20°	0·250	20°	0·271	,,	0·279	,,	,,	,,	29° 20′	116° 30′	20° 40′
,,	30°	0·315	30°	0·329	,,	0·345	,,	,,	,,	32° 30′	119° 30′	17° 30′
45°	0	0·172	0	0·176	45°	0·179	50° 20′	39° 40′	22° 30′	22° 30′	117° 50′	22° 30′
,,	20°	0·190	20°	0·219	,,	0·226	,,	,,	,,	26° 0′	121° 20′	19° 0′
,,	30°	0·230	30°	0·260	,,	0·272	,,	,,	,,	28° 35′	123° 55′	16° 25′

Atmospheric Pollution*

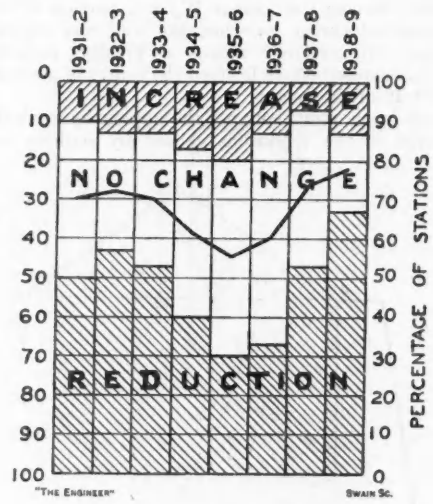
THE Committee have again been mainly concerned throughout the year with the work of the Survey of atmospheric pollution in and around the City of Leicester. The second year of routine observations has been completed and the Committee are satisfied that excellent progress has been made during this period. There is no doubt that this study of atmospheric pollution, which has considerable scientific interest, will prove of the greatest value in providing guidance in the practical application of atmospheric pollution research in the public interest.

In the course of the year the Committee made a careful examination of the programme of work in progress and of the results obtained during the first eighteen months. In the light of this review they considered how the subsequent work of the Survey could be planned to the best effect, and reached the conclusion that, if full advantage were to be derived from the observations already made, it would be essential for the work to be maintained without reduction throughout a third year (1939–40). A Sub-Committee appointed to consider what modifications should be introduced into the programme of work after March 31st, 1939, found that in several cases the two years' observations gave enough information. They therefore recommended that certain routine observations should be discontinued so that the Survey staff could be made available to study special problems of great interest which arose out of this work and to start work on the analysis and report on the observations already made. As in the earlier work, particular importance is attached to those problems which require for their solution a network of stations, such as has been established at Leicester.

The Sub-Committee's recommendations, which were endorsed by the Committee, suggested the measurement of dust and sulphur at a series of stations in a line stretching eastwards from the centre of Leicester; this has necessitated the establishment of two new stations about 1 mile and 5 miles east of the city. In addition, it was agreed that measurements for the determination of turbulence in the air should be made, since it has been found that this is the dominating factor in casual variations of pollution. Work will also be continued on estimating concentrations of dust in the air by direct weighing, to which reference was made in the Committee's report last year, and on the deposition of soluble and insoluble matter. The statistical work on the the preparation and analysis of the results will also be begun. The routine observations which it has been decided to discontinue, include measurements made with the deposit gauges, lead-peroxide apparatus, and the daylight apparatus. The Committee are glad to learn that observations with the deposit gauges at Humberstone and the Town Hall and with five lead-peroxide instruments, which have been made by the Leicester city authorities for many years past, will be resumed after the interval of two years during which the gauges have been maintained by the Survey staff.

The special daylight-measuring instruments, which were described in the Committee's report for 1936–37, and which have been in use at eleven stations at Leicester, have proved to be satisfactory. It was felt, however, that further tests under conditions of routine usage were desirable, and the Committee are grateful for offers from various members to maintain one or more of these instruments during a trial period.

The discontinuance of some of the routine observations has meant that certain of the observation stations of the Survey have been vacated altogether, and the Committee take this opportunity of acknowledging their indebtedness to the Leicester Saturday Hospital Society and the Glen Gorse Golf Club both for the facilities which they have provided and also for the helpful and kindly manner in which the Survey staff have always been welcomed. The Leicester city authorities have continued in many ways to provide valued assistance, without which the work of the Survey must have been severely handicapped.



TOTAL SOLIDS DEPOSITED

The Committee referred in their last report to a technical conference of persons directly responsible for the observations and associated analytical work undertaken by the co-operating bodies whom they represented. This was held in March, 1938. The Committee have since given careful consideration to all the points which were raised in the course of the discussions, and, as a result, revised instructions for the use of the deposit gauge and instructions for the analysis of matter collected in the gauge have been prepared and issued to those authorities which make measurements by this method. The preparation of these revised instructions required some experimental work, and the Committee are grateful to those members who have assisted in this work. Some questions raised have not yet been satisfactorily settled; for example, carbon bisulphide, which is still recommended as the standard solvent for tarry matter, has several serious disadvantages and a better solvent is being sought.

The Committee have examined a suggestion made at the technical conference that a source of chimney grit might be identified if some of the fuel used in the furnace were to be treated with radioactive material. Experiments to test this have recently been carried out, under Mr. Collie's supervision, at the Fuel Research Station, and the Committee are awaiting the results with interest.

The Committee are now satisfied that the combined apparatus for the volumetric measurement of sulphur dioxide and black suspended matter is a useful instrument and suitable for general use. An experimental clamp for holding the filter paper, which was designed for the Committee by the Superintendent of Observations, has been on trial; its recommendation as a standard instrument is still under consideration pending the results of these trials.

* From the report of the Atmospheric Pollution Research Committee of the D.S.I.R. for 1938–39.

The Committee have received from Mr. Andrews (Chemist-in-Chief of the London County Council) the results of experiments which he has performed on the use of antiseptics in deposit gauge bottles and their effect on the determination of sulphates. References to previous work on this subject by Mr. Shelbourn, Mr. Tankard, and Mr. McLachlan were contained in the Committee's report for the year 1936-37 (twenty-third report). The Committee have now reached the conclusion, on the basis of the results which have been reported to them, that the use of antiseptics in deposit gauge bottles is not necessary, apart from the normal use of copper sulphate. The Committee wish to record their appreciation of this assistance given in making available the results of these experiments.

The Committee have received with interest the results of measurements of atmospheric pollution made in Dublin by Dr. A. G. Leonard, of University College, Dublin. Measurements have been made with a deposit gauge, lead-peroxide apparatus, and an automatic filter. Some results which Dr. Leonard supplied were published in the twenty-fourth annual report, and further measurements are included in the report of the Superintendent of Observations in the present report.

If the total solids be taken as a summary, and the current year be compared with last year, we find that there is an improvement—that is, a reduction of deposit—at 67 per cent. of the stations this year compared with 55 per cent. last year. On the other hand, an increased deposit was shown at 13 per cent. of the stations compared with 9 per cent. last year, while 20 per cent. this year show no change compared with 36 per cent. last year. These figures, and the corresponding figures for a similar group of stations for the past eight years, are shown in diagrammatic form. If we make the assumption that any random variations will cause as many stations to show increased deposits as decreased, the difference between the number showing increased deposit and decreased deposit will be a rough measure of the general trend of impurity deposited for this group of thirty stations. The ordinates which give rise to the line drawn through the centres of the unshaded portion of the diagram (which represent the number of stations showing no change) are proportional to this difference, and the line thus represents the general trend of deposit, upwards showing an improvement, and downwards a deterioration.

To what extent the effect thus shown is due to changes in industrial activity (which may give rise to increased smoke and dust due to building activities, &c.), or is due to a more permanent movement to keep the air clean, it is not within the scope of this report to estimate.

Obituary

HERBERT CYRIL ARMITAGE

Midland engineering circles have suffered a great loss by the death of Mr. Herbert Cyril Armitage, who died suddenly on Sunday, September 29th. He was only fifty-two years of age.

From 1916 until March of this year Mr. Armitage was efficiency and production manager of the Austin Motor Company, Ltd., Northfield, and since then had been manager of Rootes Securities Factory at Coventry. Leaving Sir Joseph Williamson's Mathematical School, Rochester, in 1901, he began his training work under his father at Aveling and Porter, Ltd., Rochester. In 1902 he went to Ruston and Hornsby, Ltd., Grantham, to complete his training. In 1909 he went to Mather and Platt, Ltd., Manchester, where he rose to the position of assistant works manager and works engineer. During the last war, from 1914 until 1916, Mr. Armitage was works manager at Cogswell and Harrison Company, Ltd., small arms manufacturers of London, where, besides being responsible for all designing and manufacturing departments, he was instrumental in starting the works on war contracts for periscope parts and light war materials.

At the Austin works he was responsible for all technical matters relating to production of tool designs and works orders for jigs, tools, plant, buildings, &c. Work undertaken by him included the development of job planning in the workshops and reduction in labour costs.

He was Chairman of the Executive Committee of Research at Birmingham for some time, and was also a member of the Institute of Chemical Engineering.

Canada and United Kingdom Export*

By NUGENT M. CLOUGHER, A.C.G.I., F.R.G.S.

Through many years the British manufacturer has encountered numerous obstacles in the way of placing export to Canada on a satisfactory basis. These obstacles have resulted from many causes, and I am bound to believe that most of them may be traced to causes connected with the manufacturing organisation itself.

Export trade is an all-important matter, and, far too frequently, has been looked upon as a side issue. This great upheaval, through which the world is now passing, is teaching many lessons, and probably one of the greatest is the bringing home to us of the need for greater expansion abroad. The many weaknesses in our past organisation, also, have been brought to light.

If we believe that this expansion is of the vital importance to us as a nation that we are beginning to understand, then we must see to it that the continuity of effort is maintained. We are told, as we must all realise, that trade abroad is essential for the increase of credits. If this is all, then the fabric which we are now building is liable to crash when the need that caused its creation is no longer present.

To my mind—and I trust that you will agree—the all-important matter is the creation of a solid export trade that will continue through the years that are to come. This must be looked upon by the Government as a real trust and heritage to be handed down from the days of this great struggle. These remarks are not irrelevant in considering export trade with the great North American Dominion. Such is the importance of the field, that general remarks on export relate, in large measure, to this great integral part of the Empire which has such potential possibilities for the consumption of goods from the British Isles. This is true not only for the natural consumption of imported goods, but there also exists a very real inclination to products from the Home Land.

A few minutes can usefully be spent in considering some of the causes of any failure that may have been met in the past, and so build up safeguards to prevent any repetition.

Far too frequently one finds that the general get-up and selling price do not conform with local conditions. It may be that the Canadian price is taken as merely a close equivalent to that in Britain, irrespective of the fact that current practice is to market products at standard prices, such as a dollar, dollar and a half, or two dollars. Often the general styles cannot hope to compete with those which have become customary in the Dominion, and so sales have not come up to expectation.

One knows of many cases where the sending of goods abroad has been only an excuse to cover up overproduction at home, or, on the other hand, to increase production with the idea of reducing unit cost. All this has been undertaken without consideration of local demands, and that goods are suitable for the market.

Examples are certainly not lacking where an energetic sales development has been destroyed through not maintaining local stocks on site. Demand has been created, and failure to have supplies ready at hand has simply increased competitor sales.

Much disheartenment may result from sales campaigns that are either too extensive, or else too limited. This has been a frequent outcome of development that has not been based on sufficiently sound study. Situations are too frequent where ambitions have not been realised through taking up information that is unreliable, inadequate, or is not sufficiently specialised for a particular firm.

One comes across some very strange conceptions of distribution, and many a British exporter who has considered Canada with hope and enthusiasm has been compelled, ultimately, to admit failure by the appointment of the wrong distributors. The right distributor will open the door wide leading to the substantial purchasing public of the Dominion. A wrong distributor may be so fully occupied, or find so many obstacles, that he is unable to get the door more than partly open.

May I be forgiven for saying that a great deal of failure, where it is found, may be attributed to a lack of driving force on the part of the export manager, or, on the other hand, a tendency to "let things just happen." Too frequently he is content with the polite correspondence that is exchanged between the exporter and importer, and how often does one hear the expression, "Well, I know he is doing his best, but . . ."

There is definitely a failure to carry the best parts of army organisation into the fight for export trade.

Selection of the Product

The customer is always right. This oft-repeated phrase has considerable significance in the Canadian market. The buyer has a very good idea of what he wants and naturally goes to the sources that can satisfy his particular requirements. How often do we say that we have something to sell when we might better say to ourselves, "Canada requires such and such, can we supply it? Have we the thing that will suit the particular taste or fad or condition?" If the product does not fit in with present requirements we at once come up against the distributor, the retailer, and, above all, the user. All this means friction, wasted energy, and unnecessary expense. In some cases the bringing about of a change of outlook is worth all this endeavour, but this must be in very special instances and not be contemplated by the everyday producer that desires to export to Canada.

Where products in Great Britain differ greatly from those required in Canada, it is seldom wise to try to establish a market for the goods as used at home, unless the manufacturer is in a position, and is willing to put aside quite considerable sums for the developing of the field along the lines of his special article.

There have been cases where groups of specialised manufacturers in Great Britain have entered into agreements with the corresponding manufacturers in the Dominion whereby the field is divided and arrangements made not to overlap. A difficulty that has been experienced in this connection is where the British producer agrees to export only types not manufactured by corresponding concerns in Canada.

With the development of Canadian industry, alterations have been made and these have involved the production of new types previously imported under the Agreements. In these cases losses may be incurred by the British manufacturers in having to give up fields on which both time and money have been expended.

Competition

Although the competition that will be encountered in the Canadian market is looked upon as opposition, yet in reality the British exporter approaching the Canadian field is himself the competitor in a field that probably has a certain degree of coverage. Although realising this, for the purpose of discussion we will consider other brands of similar products as competitors. These come under three classifications:

The competition of Canada-produced goods;
The competition from countries external to Canada; and
The competition of other firms in the United Kingdom developing the Canadian market.

The first of these three—the local competition—is fairly serious. Not only are such producers likely to have considerable influence on the policy of the Government as regards specific imports, but also they are faced with the minimum of transport charges, and generally are able to obtain their raw materials locally. Their selling organisation is in closer touch with the production departments and, being on the spot, it is possible to gauge carefully the trend of taste of the buying public.

There are many factors bearing on the opposition to be expected from firms external to Canada. The probability is that the producer in Great Britain has an advantage regarding tariffs, or at least is in no worse a position than any other exporter in this respect.

Generally speaking, Canada's imports may be considered to come from the United Kingdom or the United States. Exports of other countries to the Dominion are considerable under certain categories, but seldom exceed two million pounds per annum and in general are much less, for such a classification.

The United States, in some ways, has much of its production machinery rather tied up, and Britain's requirements are increasing, due to failing source of supply.

The fact that the British Government is standing behind its policy of placing export trade as one of the vital sinews of war has changed the condition in the United Kingdom and given British manufacturers an unusual opportunity of extending their fields and taking over markets formerly held by foreign countries.

With the combina ion of effort of the Government and the manufacturer, it should be possible to place export trade to Canada on such a solid basis that a very large percentage of the increased revenues from overseas trade may be retained after the cessation of hostilities.

The Distributor

The distributor holds the key to unlock the valve which regulates the flow of goods from the manufacturer to the consumer. He hunts for the shelves ready to receive the goods. He fills them from his stocks, and keeps the stocks supplied by shipments from the manufacturer. He must keep a careful balance, and if there is a mistake in any of the operations he is controlling, the manufacturer is bound to suffer.

In Canada it is essential to find the right distributor for the right product. Generally speaking, the sphere of successful operation for the distributor is within definite limits, and beyond those limits there is danger of a serious falling-off. Each section of the country has its own problems, and possibly these may best be understood by distributors operating in the particular zones.

Distributors have a saturation point, and the number of firms that it is possible to represent, and to whom they can give adequate service, is limited. It may be contended that an organisation can be

* Excerpt from *Export Journal*, Institute of Export.

increased sufficiently to cover representation of an almost unlimited number of lines. How far this expansion can take place without affecting the various firms is a matter of argument, and must be considered by the exporter before an appointment can be made.

Among other things, a note must be made of lines and types of goods that may be handled with advantage in conjunction with those produced by the manufacturer. This is not all, for it is of even greater importance to know the sources of origin of other lines handled. Some distributors claim to specialise in the products of, say, the United Kingdom, or of the United States, or of other countries. It is not so much the fact that the goods have origin in one place or another, as it is that the manufacturers in these countries carry on their business arrangements with the distributor in different ways.

The producer in Great Britain is inclined, all too frequently, to leave things to the good offices of the representative, while the manufacturers, in the case of other firms represented by the same distributor, keep up a regular bombardment of queries, reports, suggestions, ideas for expanding business, and so on.

May I put it to you in this way : if you were in the position of the distributor with only twenty-four hours in the day, and were under heavy bombardment from some manufacturers, and occasional " you know best " letters from other manufacturers, what would you do about keeping things moving ?

This is not the whole picture, for time after time the serious distributor is making very excellent suggestions that might add to sales, and these suggestions are not receiving the prompt consideration and decision that they warrant. Whereas it is true that the British manufacturer may not appreciate the problems of the Canadian distributor, it is equally true that the distributor, concentrating on sales increase, may not understand fully the position of the manufacturer, who has to balance his judgment in matters relating to his home sales with distribution in countries all over the world, and this in addition to the Canadian field. There is need for much closer understanding of the various problems and methods of doing business, and as this increases so will export trade be further developed.

Before leaving this all-important subject of the distributor, may it be stressed that it is absolutely essential to secure the right distributor, and the selection should not be determined by the fact that the distributor uses high-class note-paper, but rather because the distributor is in a position to continue to maintain sales for the particular goods.

A study over a number of years has shown that in some cases the distributor with the large organisation is particularly suitable, whereas in other cases the one-man business may give better results. The one-man business may not have the same financial resources, but it may have a driving force and personal interest that are vitally required by the new exporter to the Dominion.

Other manufacturers may consider that the larger organisation has greater experience to work on, and has more men on the road, even if the new products are only a few of the many lines handled by such an organisation.

The reaching of a correct decision on this matter is vital, and on it may rest the entire future of Canadian sales.

The Consumer

The all-important part, the absence of which would mean the breakdown of the entire export organisation, is the customer. Everything that is done leads up to this end, where continuous outgoings are changed to income. With all its importance it is surprising to find how often the consideration of the customer is given a comparatively small place in the study of export. There is always the great fact that we have things to sell, and the problem of how these things are to be sold. The real question which faces us is : " What does the Canadian consumer want, and are we in a position to supply it at a reasonable price ?"

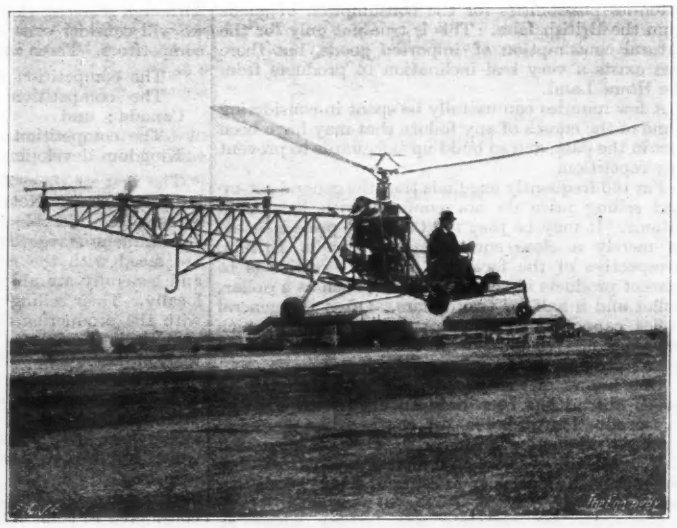
I am not one to believe that the consumer has lost his individuality in deciding what he does or does not desire to acquire. Many feel that high-pressure salesmanship will sell goods irrespective of other considerations, and that the buyer can be made to like what he can get. To me, this view seems to lower the whole field of export and bring it down to a hold-up, rather than raising it to the science that it really is. In saying this, it must not be assumed that one does not believe in giving the consumer full opportunity of studying the merits of new products, nor should he be deprived of the chance to follow the new ideas that progress will bring out. What is intended is to show that analyses of the tastes and fancies of the consumer must be made, and the goods placed before him backed by real worth, and thus develop the confidence that should exist between the producer and the manufacturer of standard products.

If Halifax or Winnipeg or Vancouver wants things in blue instead of red, it is much cheaper to change the dye than it is to convince the customer that he is wrong : the customer may be right.

Sikorsky's Helicopter*

In our September issue we reported on Igor Sikorsky's views regarding the utility of the helicopter in military operation. With these views we agree thoroughly. But the pioneer inventor does not merely hold views ; he builds aircraft to substantiate them. Witness the V S-300 helicopter, recently constructed and tested in the plant of Vought-Sikorsky Aircraft.

The new helicopter, as indicated in our photograph, is equipped with a single lifting rotor, three-bladed, and 28ft. in diameter. There is considerable advantage in a single rotor, because the maximum lifting and forward flight efficiency are secured thereby, and because the overall dimensions are kept down to a minimum. Moreover, with the engine placed immediately below the rotor hub, the transmission system is reduced to its barest elements. With a single lifting airscrew, there is, however, a turning moment to take care of ; the fuselage and its occupants would otherwise spin around dizzily in space. This difficulty is met by placing a small auxiliary airscrew at the very tail of the helicopter, rotating in a plane which is parallel to the plane of symmetry of the helicopter. With this plane of rotation, the auxiliary airscrew provides lateral thrust and the turning moment of this thrust counteracts the torque of the main rotor. When the pitch of this auxiliary airscrew is varied, its thrust is varied. Hence, rudder action is provided.



HELICOPTER IN FLIGHT

The reader will note that there are two other auxiliary airscrews, mounted on outriggers from the tail end of the main fuselage. The pitch of these screws can also be varied at the will of the pilot. If their pitch is varied simultaneously they give longitudinal control : that is, control in pitching the craft up or down. If the pitch of the two outboard screws is varied differentially, they give lateral control like the ailerons of an aeroplane.

Thus the Sikorsky helicopter has control about all three axes (which is an essential of all aircraft). Since the controls are engine driven, they are operable when the machine is hovering, while ordinary movable control surfaces are operative only when the aircraft has forward velocity.

To secure vertical ascent, it is only necessary to give the blades of the main rotor a fairly large positive pitch. While the machine has not yet risen to very high altitudes, the photograph indicates that ascent has been achieved. Forward flight is achieved by simply inclining the machine forward—that is, nose down—using the elevator airscrews for the purpose. Thus the thrust of the main rotor has a forward component which serves to accelerate the machine in a horizontal direction. As a matter of fact, the helicopter can go forward, backward, or sidewise.

In case of engine failure, the pitch of the main rotor will automatically decrease so that vertical or gliding descent at a steep angle will become possible, just as with an autogiro. The auxiliary screws remain in the same mechanical connection with the main screw whether power is off or on. Therefore the auxiliary screws remain operative as controls, even when the engine is dead.

We congratulate Mr. Sikorsky on an elegant solution of the helicopter problem, and await further progress with real expectations.

* *Scientific American*, October, 1940.

Some Aspects of Rolling*

By J. F. WHITFIELD, B.Sc.

Introduction

As long ago as the seventeenth century the pioneers of what is now a highly developed industry were subjecting hot iron to the modified forge-pressing process of elongation between cylindrical rolls. The subsequent development of the modern rolling mill in its many forms, together with the art of controlling the shape of the final product, have largely been the outcome of progressive engineering application to the mechanical construction of mills and their auxiliaries, coupled with the practical experience embodied in the highly specialised and individualistic art of the roll designer.

The present-day mill roll stand is the natural result of this practical progress, at least up to a few years ago, and in contrast with steam and electric power units, it owes little of its present form to the application of purely theoretical analysis and scientific research, as is the case with the steam and electric drives operating on such mills. This is by reason of the fact that, first, the theoretical principles underlying the process of rolling are by no means simple, and are not even yet fully understood, and, secondly, the necessity for selling the finished products has meant that most of the experimental work which must be included in scientific research, has, of necessity, already been carried out in the industrial mills themselves, and the results known and acted upon. This applies particularly to the control of the profile of the rolled product.

These considerations, however, do not conflict with the point of view that a rolling mill stand with its rolls, bearings, and housing assembly, may be regarded as a piece of engineering equipment, the essential duty of which should be to produce the required profile accurately and with the minimum expenditure of energy, time, and maintenance.

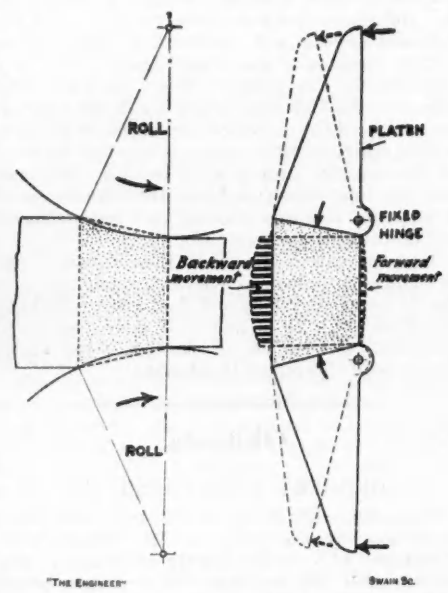


FIG. 1—*Diagram illustrating Analogy Between Rolling and Pressing.*

Profile accuracy is the exclusive problem and responsibility of the roll turner and mill personnel, who, to a certain extent, may also influence the time factor, but this question of time factor, together with the economical utilisation of power and the minimising of maintenance costs on the mechanical parts of the mill stand, is largely the responsibility of the engineer.

With the exception of modern continuous mills, the efficiency of a mill stand considered as a mechanical unit is generally low. In view of this, it may be helpful to review the nature of the work which the rolls and stand are called upon to do, excluding cold rolling, and to outline the principal factors which influence this efficiency.

Squeezing of Material Between Rolls

Assuming perfectly plastic material, the squeezing of material between rolls has often been compared with simple vertical compression of a block of the substance between flat horizontal plates. This analogy has its value in enabling us to understand the effect of skin friction between the compressing surfaces and of lateral spreading of long and short specimens, but in this case, however, surface friction is not necessary to produce change of shape, whereas

* Cleveland Institution of Engineers

it is, of course, essential in rolling. The pinching action of a pair of rolls may perhaps be better illustrated by the hypothetical hinged presses subjected to the forces shown in Fig. 1. Surface friction must be present or the material could not be squeezed, and the resulting change of shape shown dotted produces a slightly forward movement or lead to the right and a relatively greater amount of backward movement to the left.

EFFECT OF SURFACE FRICTION BETWEEN BAR AND ROLLS

This factor, as is already known, influences the biting effect, and also the entry of the bar between the rolls, as shown in Fig. 2, which illustrates the maximum allowable angle of bite or contact for effective

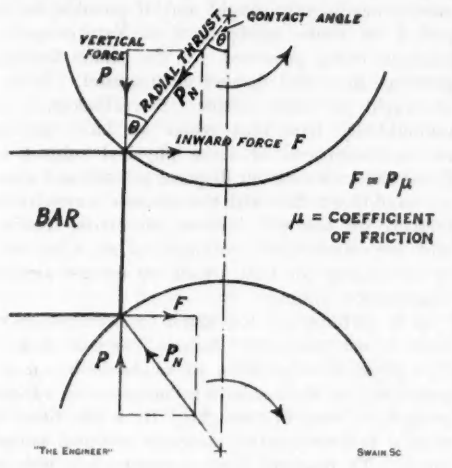


FIG. 2—*Frictional Influence Governing Entry of Bar Between Rolls*

entry, the tangent of this angle being equal to the coefficient of friction between the material and the rolls. This frictional coefficient has been determined for flat rolling by various experimenters from the above relationship and also by other means. It naturally increases with roll roughness and ragging and the presence of scale and also decreases with increased bar temperature, as shown in Fig. 3. It also decreases with roll speed and the presence of

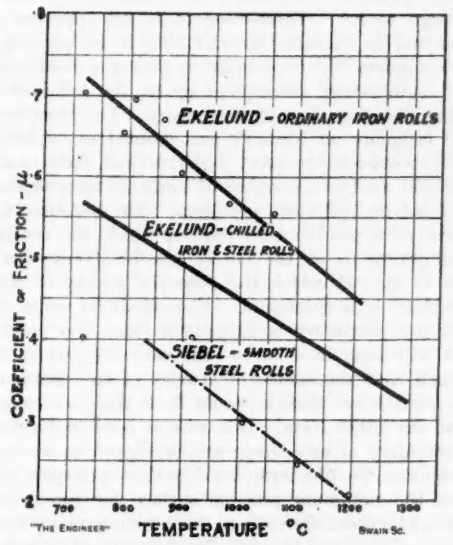


FIG. 3—*Coefficient of Friction Between Steel and Rolls*

water between the rolls and the bar, so that its determination can only be approximate.

After the bar has entered, the resulting flow of a plastic material, to which hot steel above the critical temperature approximates, in the biting or contact region is complex, particularly in forming passes. It is subject to many variables and without wishing to complicate the issue, passing reference may be made to the chief factors influencing it, which, apart from the restraining action of collars and the effect of inclined grooves, are as follows:—The surface friction which is necessary and always present between the bar and the rolls, the circular shape of the compressing element in the form of the roll and its diameter, as compared with bar thickness and draught, temperature differences between the inside and outer surfaces of the material resulting in variable plasticity, and also the work hardening of the material. All these influences play their part, the work-hardening effect, although having little significance in hot rolling, is of extreme importance in cold rolling.

Fundamentally, hot rolled material deforms by relative sliding action between the internal particles or crystals, along innumerable slipping planes at approximately 45 deg. to the pressing force, as shown in Fig. 4. The general behaviour of hot rolled steel in the case of simple rolling—"simple" is emphasised—is shown in this same diagram, for plain cylindrical rolls. The volume of the bar being rolled remains substantially constant during reduction and the bar volume entering the rolls per second must equal the volume per second leaving the rolls. Since the area at entry is greater than on the delivery side, the velocity at entry due to the greater area is less than the delivery speed, and the steady speed of the roll has thus to encounter a variable speed of the bar,

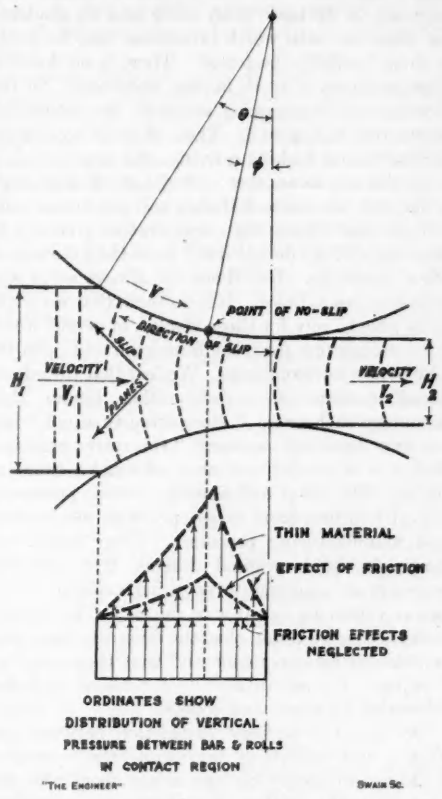


FIG. 4—*Behaviour of Plastic Material Between Plane Cylindrical Rolls*

with the result that slippage takes place at the surfaces between the bar and the rolls, particularly during the early stages of the bite and also inside the material. Since the delivery speed of the bar is very nearly equal to the roll speed, there will be one point on the biting surface at which the bar surface speed and roll speed are the same, and there is no relative slip between the two. The calculated position for the case illustrated is shown in the figure. The position of this no-slip point varies slightly with the amount of draught, and the magnitude of the surface friction.

Before the no-slip point where most of the reduction

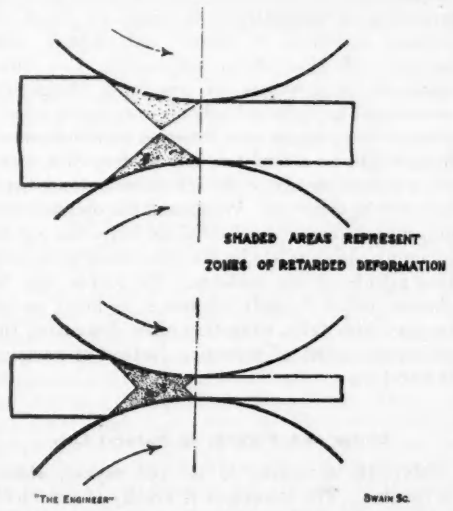


FIG. 5—*Effects of Friction related to Thickness of Bar*

takes place, the bar is moving slower than the rolls, or backwards relative to the rolls, which exert a forward scrubbing or tension effect on the bar surface, depending again upon the draught and tending to bend over the tops of the originally straight vertical lines as shown, assisted by the bellying action of the inner part of the material shearing along 45 deg. planes. This scrubbing action causes roll abrasion and wear. After the no-slip point there is no surface slipping, but there is a slight amount of internal extrusion effect, or lead, as shown originally in Fig. 1, particularly on wide bars, where the spread is relatively small. This is familiar to all rolling mill people and results in the bar leaving at a slightly higher speed than the rolls. This forward slip increases with roll roughness and draught, but rarely exceeds 5 per cent., and is less than this on narrow material where the spreading effect is more marked.

In squeezing a plastic substance in direct compression, the amount of friction between the two surfaces in contact has an important effect, and, as is well known, results in a higher pressure being required to overcome the frictional restraints than in the case where the compressing plates are perfectly lubricated. This is particularly the case with squat or shallow specimens. The rolls in their capacity of a deforming tool have the same extra frictional pressure to deal with in carrying out the necessary reduction on hot steel. This surface frictional influence of the rolls penetrates the inner structure of the material being rolled to an extent dependent upon its thickness, as shown diagrammatically in Fig. 5. This tends to retard flow in the areas shown shaded, and thus increase the necessary rolling pressure.

In the biting region the resulting distribution of vertical pressure which is responsible for producing the separating force between the rolls is somewhat on the lines as indicated in Fig. 4. The additional pressure required to overcome surface friction will be observed and reaches its maximum at the no-slip point. Thin material, as previously mentioned, needs greater average pressure and hence more rolling power to overcome the increased internal constraints caused by the surface friction for the same reduction and roll diameter. This is partly offset by the smoother rolls in hot plate and sheet mills, and is minimised as far as possible by oil lubrication of the work rolls in continuous cold rolling mills. The increased separating force encountered in plate and sheet mills is largely due, as is well known, to the large width of plate and to the low working temperature caused by the chilling effect of the large area of roll surface in contact with the material, necessitating, in two and three-high mills, stiff large diameter rolls and high bearing loads.

(To be continued)

Sixty Years Ago

THE PHOTOPHONE

FOLLOWING his invention of the telephone, Graham Bell turned his attention to the transmission of vision by telegraph. It would appear, however, that during his study of this subject, his investigations led him along other lines, and resulted in the development of the "photophone," a system by means of which it became possible to telephone along a beam of light without employing wires of any kind for connecting the transmitting and receiving stations. Particulars of this invention were given in our issues of September 24th and October 15th, 1880, the second-named issue containing a reproduction of a paper describing the photophone, which Bell had read before the American Association for the Advancement of Science. The system made use of the light-sensitive properties of selenium, and embodied the idea of causing a beam of light falling upon a piece of this element to vary in correspondence with the vibrations of the human voice. The varying resistance of the selenium under the varying intensity of the light falling upon it was made to affect the current flowing in an electric circuit into which a telephone was connected. This idea had been suggested by others previously, notably by Willoughby Smith, who was the first to call attention to the light-sensitive properties of selenium. It was found, however, that selenium in its crystalline or "metallic" form possessed a resistance much too high to enable it to be used in the intended manner. Bell, however, succeeded in treating it in a manner which greatly reduced its resistance and in constructing selenium "cells," which were sensitive enough to permit the fall of light upon them to be rendered distinctly audible. In his paper before the American Association Bell stated that he had succeeded in transmitting speech along a beam of sunlight over a distance of more than 650ft., and that success had also been attained with the use of oxy-hydrogen light and that from a kerosene lamp. He had, he reported, made experiments with the object of ascertaining the nature of the rays which affected selenium. He had found that a solution of alum or bisulphide of carbon placed in the path of the light slightly diminished the intensity of the sound in the telephone, and that a solution of iodine in bisulphide of carbon cut off most, but not all, of the sound. Using an apparently opaque sheet of hard rubber, he discovered that the sound was not completely suppressed. He therefore concluded that there existed certain invisible rays which could penetrate a sheet of hard rubber, and that selenium was sensitive to their impact. A further experiment showed that these rays could even penetrate two sheets of hard rubber with a solution of alum between them. In all these experiments the sound transmitted was not the human voice, but a musical note produced by interrupting the beam of light through the agency of a rapidly rotating disc with perforations round its edge.

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OCTOBER 18, 1940

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CREATIVE ABILITY

AT a recent meeting of the American Society of Mechanical Engineers the encouragement of creative ability was discussed. A paper of particular interest was one by Mr. A. R. Stevenson, jun., and J. E. Ryan, from which we reprint a few extracts on page 252. These authors are both associated with the General Electric Company of Schenectady. Hence they speak as practical men upon a practical subject. By creative ability is meant the power to invent. Now, invention is a child of the imagination, and the problem which has to be solved is how to stimulate and quicken imagination in young engineers. American colleges, it would appear, are doing nothing to help. Indeed, they seem to be doing just the reverse. "The lack of emphasis on the scope and importance of design engineering during undergraduate years has caused many college students to look upon a designer as a routine draughtsman. If this misconception be allowed to continue, the really good men will shy away from design still more, and none but the mediocre ones will be left to carry on the vital work." We have little doubt that the same charge might be levelled against engineering schools and universities the world over. And so long as the examinational and degree system prevails, it will continue. The purpose of education is to fill students with just that amount and quality of learning that will enable them to answer a set of questions that are virtually stereotyped. They may be encouraged to exercise a little common sense—not to be mere parrots—but little or no attempt is made to encourage the engineering imaginations of undergraduates, and in the post-graduate courses—limited to a few—the work, if we may judge from papers and theses, is more often than not research of a routine character with familiar subjects.

It is frequently said that inventors are born, not made, and that no school can be reasonably expected to do more than instil into its students the materials with which inventions may be made or their feasibility be tested. There is no doubt a large modicum of truth in that statement. Of the thousands of engineering students, few nowadays have a real calling to it. Their object is to prepare themselves for making a living, and engineering is as good a way as another. They have no flair, and, in the end, are content if they can get into a comfortable and reasonably remunerative groove. In this respect they do not differ from the followers of other vocations. But there are always some who are engineers at heart. It is on them that we ought to be able to rely for those strokes of genius which raise engineering from the humdrum and open the way to new developments. We fear that the educational systems of to-day rather hinder than encourage such men. "More often than not," say our two American authors, "the really ingenious designers of to-day are men who have come up through the shop and drafting room, possessing a wealth of first-hand experience with mechanisms and manufacturing processes. Their minds can synthesise bold, original designs, free from the necessity of analysing everything mathematically before venturing to put it on paper." The implication here is, we think, that the designers have been self-taught by experience and that they have not "enjoyed the advantages" of a liberal technical education in school and college.

We like the authors' distinction between synthetic and analytical invention—the synthetic, building up boldly by experience from the raw materials, the analytical, scrutinising everything mathematically, before it ventures to express an opinion whether it will work or not. The former is, by nature, constructive; the latter destructive, timidly seeking to find a flaw and doubtful of all that it cannot prove by x, y, and z. Not from them, but from the daring ones have great inventions sprung. Has a mathematician ever made an invention by mathematics? Parsons, a wrangler, was the nearest, but the turbine ran far ahead of the mathematics. Edison was no good at sums, and one of their own number has admitted that the whole lot of the pioneers of electricity generation knew next to nothing about the subject. Mathematics is quantitative, and the synthetic invention is qualitative; it aims to reach a purpose somehow or other, and cannot wait to be told that it is impossible. Can that spirit of doing things, of imagining things, be encouraged in technical schools and universities? Our authors suggest one direction in which something might be attempted, but we fear that without a radical change of the scholastic outlook little can ever be achieved. We hazard the opinion that no professor under the sun thinks it his business to encourage deliberately by his curriculum the inventive talents of his students. He leaves that to chance, and, unhappily, chance is as likely as not to play him false, education often destroying the embryonic spirit of invention instead of warming it into life.

Cause and Purpose in Natural Law

NATURE, according to the old saying, abhors a vacuum. The statement is worthy of consideration not from the point of view of its physical truth or untruth, but from that of the general attitude towards natural phenomena which its expression embodies. In nearly every branch of science statements couched in similar anthropomorphic phraseology are to be found, and in not a few cases they are accepted as the ultimate expression of a natural law or something closely akin to a natural law. The kinetic theory of gases has taught us better than to believe that the collapse of a vacuum ensues from Nature's abhorence of an empty space. Modern astronomical research, indeed, indicates that in the vast interstellar regions of the Cosmos, Nature, far from abhorring a vacuum, revels in a state of tenuity far beyond anything which man can produce with the most refined laboratory equipment. In saying that Nature revels in a vacuous state we are, of course, fully as guilty of an anthropomorphic mode of expression as if we said she abhors a vacuum. The ease with which we slip into such a mode of stating our conclusions concerning natural phenomena shows that in spite of the progress of scientific knowledge we of this generation are still influenced by the habits of thought of an earlier age; an age when not only the cause, but the purpose of every phenomenon was eagerly sought and, if possible, interpreted in terms implying that Nature was a sentient being governed by the same feelings, passions, likes and dislikes as mankind. To-day we ought to know better. Nevertheless, it is undoubtedly true that when we have pushed our investigations of some physical subject as far as the means at our disposal permit, and when we stand face to face with the ultimate unresolvable factors, we are still inclined to invoke Nature and her mysterious workings as an easy way of accounting for that which we cannot explain in any other manner.

It is perhaps not too much to say that every time we use the word "Nature," or hear it used, in a physical connection, we ought to be on our guard against the insidious influence of an anthropomorphic way of thought. It is the duty of science to look for the causes of physical phenomena. To discover their purpose may well be left to the metaphysicians. Doubtlessly, if we could discover Nature's ultimate purpose in her physical manifestations, we would have a complete key to the causes which we seek and would presumably be in a position to translate into reality, Laplace's dream of a universal formula within which all natural laws would be condensed into one. Such an argument, however, clearly begs the question as to what is meant by Nature, and whether it, or she, has any ultimate purpose in the physical manifestations which we fondly assign to her. There used to be an apparently irrefutable scientific doctrine that in all physical phenomena Nature sought to attain a condition of equilibrium corresponding to the minimum manifestation of potential energy. This doctrine of economy on Nature's part seemed to be fully substantiated by many observational facts, and is still used in a number of instances as a means of solving physical problems. The position of rest of a pendulum is that in which the centre of gravity is at the lowest possible point—that is to say, at which the potential energy of the system is a minimum. If a chain or rope of perfect flexibility is suspended from two points it will hang in a curve—the catenary—which is such that the centre of gravity of the chain or rope is lower than it would be if the curve were of any other form. If a wire is bent to form a boundary of any shape and is dipped in a soap solution, the film formed will be that corresponding to the minimum possible surface for the given boundary and therefore to the minimum manifestation of potential energy. The structure of a crystal is determined by that configuration of the atoms composing it which exhibits the least amount of potential energy. These and numerous other examples would appear to justify the belief that Nature's ruling purpose is to effect her results with the minimum display of energy. This is a wholly anthropomorphic conclusion. It tallies exactly with our own endeavours in our efforts to achieve results whether of a physical, political, military, or other kind, namely, to attain the desired result with the least possible exertion. In actual fact, the principle which we impute to Nature is wrong and has been impressed upon us by our concentration upon statical problems. When we pass to dynamic phenomena the principle of minimum energy no longer holds good. There we find Nature working not with the purpose of economising energy, but in accordance with the principle of "least action" first promulgated by Sir William Hamilton. This "action" of which Nature is so economical is not a physical entity like energy. It is uninterpretable, except as the value of a purely mathematical expression,

a certain definite integral. The Hamiltonian principle covers both static and dynamic phenomena and yields the principle of minimum potential energy as a special case for static conditions. Again, in her thermal manifestations Nature appears to be concerned fundamentally not with economy of expenditure of energy, but with increasing the entropy of the universe, a quantity which eludes definition except as the value of a certain mathematical integral. If Nature is thus concerned with the expenditure of abstractions to the understanding of which we can approach only through the gateway of mathematics, we may well ask ourselves what we mean by "Nature" and express doubt as to the existence of any "purpose" behind the manifestations which we attribute to it.

In a lecture some time ago before the Royal Institution, Professor Max Born expressed the view that the idea of finding purpose and economy in natural laws could be regarded "as an absurd piece of anthropomorphism, a relic of a time when metaphysical thinking dominated science." If there is any scheme of economy behind the "natural laws" which man has formulated it is not an economy on the part of Nature, but on the part of Science itself. The object of formulating a natural law is primarily to summarise in one general expression the factors governing a host of observational facts which would otherwise remain dissociated. Indeed, if we accept the view advanced by Ernst Mach the only justification of science is economy of thought. That conclusion seems to be borne out by the history of scientific development during the past eighty years or so. Maxwell's electro-magnetic theory of light resulted in optics ceasing to be a separate branch of science and becoming a section of general electro-dynamics. J. J. Thompson's discovery of the electron laid the foundations of a development which has resulted in bringing many of the properties of matter within the same field, and has elucidated much that was obscure in astronomy. Einstein's theory of relativity represents a further effort to bring within one compass the understanding of many diverse phenomena drawn from what were previously regarded as separate branches of physical science, while the more recent quantum theory seeks to co-ordinate many phenomena involving the manifestation of energy. That neither the theory of relativity nor the quantum theory yields the ultimate economy of thought towards which science may hope to attain is shown by the efforts now being directed towards harmonising and uniting the two theories in one inclusive theory. Modern scientific thought is tending with increasing impetus towards the abandonment of strict determinism in natural phenomena—that is to say, of a belief in the existence and operation of natural "law"—and towards the adoption of the view that what we call natural law is simply the superficial appearance of the result of the operation of chance and probability. If chance be the true cause behind what we call natural phenomena it must be true that to seek a purpose behind them can only be to waste our time and to incur a grave risk of misleading ourselves.

Mr. Robert Hadfield

We are indebted to Hadfields, Ltd., for this account of the career of Sir Robert Hadfield's father, the founder of the firm. An obituary notice of Sir Robert appeared in our last number.

Mr. Robert Hadfield, the founder of the firm, was a native of Sheffield, and not only was he respected in his native town, but in iron and steel circles in America and on the Continent. Before starting the new steel castings industry in Sheffield, he had had a wide experience as a steel maker at a firm where crucible steel, tool steel, steel wire, and cold rolled steel strips were manufactured. It may be of interest to add that the greater portion of the strip steel produced in those days was used for crinolines which were at the time the fashion in women's costumes.

The works were first started in the year 1872, under the name of Hadfields Steel Foundry Company, on the site at present occupied by the Hecla Works. Naturally, at the outset, operations were conducted only on a very small scale and were confined almost exclusively to the manufacture of steel castings. The chief desire and object of the founder was to develop, by new and improved methods, the manufacture of steel and steel castings, as he foresaw at this early date that in many cases cast steel might profitably be substituted for cast iron and expensive smith's work. In this work he was ably assisted by Mr. John Mallaband, who had entered into partnership with him.

In those days the manufacture of steel was incomparably different from the highly complex methods which exist at the present time, and the application of cast steel, as opposed to forged steel, was then viewed with great disfavour, the supposition being that it was necessary to put a good deal of mechanical work on to any structure of steel in order to make it trustworthy for the engineer's purpose. Mr. Hadfield's success was doubtless due to his recognising this fact. He diligently worked to create a practice which did not then exist, and to eradicate the erroneous impressions current at that period. It need hardly be said that success only appeared after many failures and disappointments. The difficulties, however, whatever they were, were evidently quickly overcome, for as early as 1873 the firm was awarded a Gold Medal at the International Exhibition held in London that year, for the excellency of their steel castings exhibited there. Also, at succeeding Exhibitions, both in this country and abroad, the highest awards were obtained, including gold medals at Paris in 1878 and at Madrid in 1883. At the Paris Exhibition steel castings of remarkable quality were well to the front, and the only English firm which made a notable exhibit of steel castings on that occasion was Hadfields Steel Foundry Company, which had then been engaged about six years on this branch of work. The steel castings exhibited by the firm included double and single spur wheels, railway crossings, and various types of wheels and pulleys, and examples of cast steel hydraulic cylinders were shown with walls only 2½in. in thickness, corresponding to between 6in. and 7in. thickness of metal required in cast iron to resist the same pressure with the same size ram.

The exhibits did much to convince the engineering world that steel castings could be applied for many purposes where forgings had hitherto been used, with remarkable economy both in cost and weight, and also with technical advantages. In consequence of the many advantages resulting from the use of steel castings, the manufacture rapidly came to the fore and was taken up by numerous other firms in the country.

Mr. Robert Hadfield died in March, 1888, at the early age of fifty-seven. Previous to his demise he had been in failing health for three or four years, and little by little ceased to take an active part in the management of the works founded by him.

The character and activities of Mr. Hadfield are well summed up in the following extracts taken from the local Press at that date :—

"Mr. Hadfield was one of those gifted men of business who owe their advance in life entirely to their own energy, foresight, and ability. He was, in the best sense of the word, a self-made man. He belonged to an old Sheffield family, and his mother, it may be mentioned, was sister to the father of Sir John Brown. In early life he was apprenticed to Robert Sorby and Sons, where he learned a good deal relating to the manufacture of steel. Later on he allied himself with Mr. Jabez Shipman, under the title of Hadfield, Shipman and Co., and commenced the manufacture of wire at the Attercliffe Wire Mills. This continued for some time, then Mr. Hadfield withdrew from the firm, and after an interval of five or six years, during which he devoted himself chiefly to building, he directed his energies to the steel casting business. About this time the estate of William Charles and Co. came on the market. Mr. Hadfield saw his opportunity, and, purchasing their models, patterns, and plant, he took the Continental Works, Bessemer Road, Attercliffe, where for two years he carried on an increasingly successful business. Foreseeing that steel castings were capable of great development, Mr. Hadfield boldly launched into a large scheme, much to the alarm of his many friends, who predicted that disaster would result. But Mr. Hadfield knew what he was about, and events have fully justified his action. He purchased land in Newhall Road upon which he erected the Hecla Works, where, under the name of the Hadfield Steel Foundry Company, he has ever since carried on an extensive and profitable business."

This is followed by a description of the wide activities of the firm, and then continues as follows :—

"Mr. Hadfield ever kept a watchful eye on Sheffield welfare. He greatly disliked the continued efforts of the Woolwich Authorities to enter vigorously into competition with Sheffield firms, and it was largely through his incessant protests that the borough Members of Parliament were kept alive to what was going on, and an understanding was arrived at in regard to the work to be done at the Government Arsenal.

"In steel projectiles he considered it anything but creditable to the country that we should have to be dependent upon French-made shells. He refused to purchase any of the French patents at that time offered to him, and set himself diligently to meet the emergency, the result being a Sheffield-made steel shell which has stood most severe tests with satisfactory results."

In regard to this matter of French shells, in a letter to a friend on other matters he wrote :

"Unable to say more, but you will be glad to know that whatever the celebrated Holtzer and other French shells have yet done, Sheffield can now equal."

Mr. Hadfield's son, Mr. Robert Abbott Hadfield, who had been connected with the business for some years, had during his father's illness taken over the practical management of the concern, which, on his father's death, was formed into a limited company.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

THE INSTITUTIONS AND THE WAR

Sir,—From the leading article with above title in The Engineer for August 2nd, 1940, in which you deal with the certainly very important matter of the participation of members of the engineering institutions in the war effort, there appears to be a misconception—unfortunately also apparently still current in engineering and other circles in England—that the members of the various principal engineering institutions are all, *ipso facto*, upon the National Register.

Will it be believed that even after a year at war—characterised truly by you as an engineer's war—and notwithstanding a letter to the editor which appeared in The Engineer so long ago as January 26th, 1940, members of some of our engineering institutions in overseas (foreign) service have still not been able to get enrolled upon the Ministry of Labour Central Register, a *sine qua non*, without which, according to Government rules in force, no one has any status for consideration in any national service post. Will it be believed, I repeat, that this state of affairs still exists ?

Recent requests from the Minister of Labour stating his desire to have upon the Central Register particulars of all engineers—notices respecting which requests have appeared in "Proceedings" circulated to members of the institutions—does not appear to have resulted in any change from the *de facto* continued exclusion of many British engineers in foreign countries from the Central Register ; thus apparently leaving the Minister with the impression that he has at last a record of all available engineers, which in fact is definitely incorrect.

Who is responsible for this continued isolation of overseas engineers ? Is it that certain of the institutions have "forgotten" those overseas members or is it the case, seemingly incredible, that it is a Government inter-departmental incompatibility and that the circumstances mentioned in a letter above referred to from "Midloco" are still—after all the lessons of the pre-May 1940 *régime*—still operative ?

Uruguay, Midloco.
September 14th.

Canadian War Contracts.—The Canadian Government has instituted a War Contracts Depreciation Board, which will adjudicate on the amount of depreciation which may be written off on capital expenditures incurred when a firm accepts a war contract. The duty of the Board will be to decide what contracts may be described as "war contracts," to ascertain the capital expenditure involved in executing such contracts and to determine what part of such capital expenditures will have no reasonable post-war value. Such capital expenditures are to be entitled to special depreciation allowance.

Encouraging Creative Ability*

By A. S. STEVENSON, Jr., and J. E. RYAN

Toward the close of the last century, the so-called mass-production era began. Not only were great strides made in organising men and machines to turn out mechanical products on a large scale, but the same philosophy eventually permeated the educational system. College courses began to dwell more and more on usable results rather than on the methods by which such results were obtained. Fortunately, there has been a noticeable trend toward more fundamental training in recent years, with industrial firms sharing responsibility with the colleges.

Yet, while all this development of improved manufacturing methods and more fundamental engineering analysis was going on, the creative, inventive phases of mechanical engineering were, for the most part, being allowed to shift for themselves in that the engineering colleges placed little emphasis upon them. To be sure, these orphans did not do at all badly under the circumstances; but it must be admitted that whatever stimulus has been given to this creative ability in undergraduate days has come informally through student-professor relationship.

More often than not, the really ingenious designers of to-day are men who have come up through the shop and draughting room, possessing a wealth of first-hand experience with mechanisms and manufacturing processes. Their minds can synthesise bold, original designs, free from the necessity of analysing everything mathematically before venturing to put it on paper. This does not mean, of course, that the more advanced methods of analysis which we are teaching to our young engineers are futile; on the contrary, they are needed more and more, but in their proper place. The majority of new ideas are not analysed into existence; instead, they are synthesised from sound qualitative concepts, using an active imagination as a catalyst.

Mechanical design is an art perhaps even more than it is a science. Like a musical composer who must be thoroughly grounded in harmony and the principles of composition, the designer must know his physics and mechancis. Just as a painter must learn how to prepare a canvas and mix colours, the designer must understand the properties of materials which he specifies. But who has composed great music or painted great pictures with nothing more than these technical skills at his command? So it is with mechanical design; the essential attribute is a trained, imaginative mind.

What, then, can be done to foster design ability in young engineers? Most people concede that the creative flair must be born in a man, but it remains for schools and colleges to detect this undeveloped ability and give it proper exercise and encouragement. As stated before, neither of these functions has been given sufficient attention in engineering colleges, and whatever ingenuity a man may possess is often so deeply buried under a four-year layer of erudition that it takes years for it to reappear, if it ever does. To make matters worse, the lack of emphasis on the scope and importance of design engineering during undergraduate years has caused many college students to look upon a designer as a routine draughtsman. If this misconception be allowed to continue, the really good men will shy away from design still more and none but the mediocre ones will be left to carry on the vital work.

The engineering colleges can do much to encourage the creative ability of their students by allowing them greater latitude in the selection and furtherance of machine-design-course projects. Also, arrangements should be made to permit at least the more promising students to construct these or other projects of their own in the college shops. Of course, all of this requires much more faculty supervision and guidance, but it is one of the most fruitful investments of time and energy that a true teacher can make.

It is generally conceded that each industry must continue the education of its young engineers along its own specialised lines, whether formally or informally. If creative ingenuity itself cannot be taught directly, at least the embryonic designer can be thoroughly familiarised with up-to-date engineering materials and manufacturing methods. With these building blocks, his imagination can then erect proper mental concepts of machinery which will not only operate, but will be efficient and inexpensive to build.

A Magnetic Alloy.—At a recent meeting of the American Physical Society E. A. Newbitt and G. A. Kelsall, of Bell Telephone Laboratories, New York, N.Y., introduced a magnetic alloy possessing remarkable qualities. It will be known as "Vicalloy," because its contents are vanadium, iron, and cobalt, the percentages ranging from 6 to 16 per cent. vanadium, 30 to 52 per cent. iron, and 36 to 62 per cent. cobalt. After melting it is cast into an ingot, which is hot swaged to ¼in. diameter. It is then drawn into wire or rolled into tape as desired. When in final form, it is heat treated to develop its magnetic qualities.

* *Mechanical Engineering*, September, 1940.

Air Force Targets in Germany

No. VII

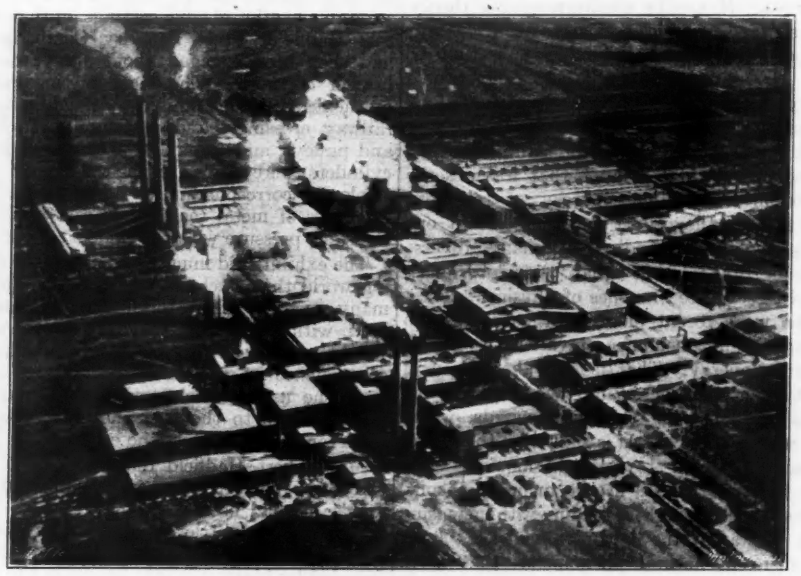
(*Continued from page 237, October 11th*)

In last week's article we gave some details of the statement issued by the Ministry of Information on Monday, October 7th, regarding the bombing of targets in Germany and the German occupied territory. It will be recalled that details were given in that statement of more than 700 blows which have been struck at Germany itself, on land and sea stretching from the Baltic Sea to Switzerland and from the North Sea some hundreds of miles inland to Berlin and beyond. In last week's article we reproduced a map showing the thickly set targets in the industrial centre of the Ruhr, particularly the Hamm district, which has suffered so far over sixty raids. To-day we reproduce herewith a larger map showing the whole extent of the German territory, which serves as target area for the machines of the Bomber and Coastal Command and the Fleet Air Arm. In studying this map it is convenient to draw a line from Hamburg, through Hanover, Kassel, Frankfurt-am-Main and Karlsruhe. The zone between that line and the Belgian and Netherlands frontier may be said to contain targets at distances of from 340 up to 370 miles from our shore bases, and this includes the naval base at Kiel, which is at about the same distance from England. In this zone are the main targets of the Ruhr district and about Cologne, and as far north as Bremen and Hamburg, which were referred to in last week's article. Our map to-day shows a further zone of attack, between the line before mentioned and one drawn from Stettin—see the hydrogenation works at Politz, near Stettin, on the top right-hand corner of the map—to Berlin, Nuremberg, Ulm and further south to the harbour and aircraft works at Friedrichshafen, on Lake Constance. In the area so formed the boundary distances are from about 440 to 550 miles from our bases, and this area covers important targets, as will be seen from the map. The power stations of Zschornewitz and Finkenheerd may be instanced, as may also the oil plant at Leuna and other centres. With the longer nights and with the use of longer-range bombers it seems probable that operations may be extended to targets still further east and south, which are no less important and have increased in importance since the reported evacuation of industry from the Rhine and Ruhr areas to districts further east.

One of the most important industries from the point of view of the prosecution of the war is the light metal industry engaged in the production of aluminium and magnesium, and their alloys which enter so largely into the design of aircraft and engines and into the production of transport vehicles and other military and naval equipment. In the articles which follow and others still to come we hope to give some account of these industries, and the steps which have been taken by the Royal Air Force to reduce their output and hinder their progress as war supply plants.

Germany's Aluminium Industry

In order to understand properly the development of the present aluminium industry in Germany it is necessary to go back to the position in that industry towards the early and middle part of the last war. At that time the shortage of aluminium was widely felt in Germany, in spite of the relatively high production of the Rheinfelden Works. In general there was at the time enough aluminium ore to hand, but, apart from one or two large undertakings, the production of aluminium and aluminium alloys was in the hands of a large number of small firms. Between the years 1915 and 1916 the manufacture of aluminium was begun at works erected at Rummelsburg, near Berlin; Horren, to the west of Cologne; and Bitterfeld, in the Leipzig district. These three works were started under the auspices of the war-time undertaking, the Kriegs-Metall A.G., which incorporated the Chemischewerke Griesheim, one of the works of the I.G. Farbenindustrie, and the Metallbank and Metallgesellschaft, of Frankfurt-am-Main, later known as the Metallgesellschaft A.G. The works were planned for a total yearly production of about 9000 tons of aluminium, which at a later date was increased to about 12,000 tons per annum. As these works were not capable of meeting to the full extent the rising demand for aluminium and its alloys, which grew up as the war proceeded, it was planned to lay down new works. Having in view the necessity of bringing these works into full production at as early a date as possible, it was decided to establish them on a brown coal basis, there being no suitable water power supply available. It was about April, 1917, that, with Government assistance, the Chemische Fabrik Griesheim, together with the Metallbank and Metallgesellschaft, of Frankfurt-am-Main, decided upon the Lauta Works, which were built at Lauta, near Senftenberg, in Upper Lausitz. The position of the works will be seen to the right of the accompanying map, a little to the north of Dresden. Other works which were started about the same time were the Grevenbroich Works, between Düsseldorf and Cologne—see map on page 236 *ante*—and the Toguy Works in Upper Bavaria.



Lauta Aluminium Works

At the close of the war the aluminium works at Lauta, Bitterfeld, Rummelsburg and Horren were amalgamated under the control of the Vereinigte Aluminiumwerke A.G. After peace had been declared the Bitterfeld works were separated from the combine and were entrusted to the original founders, the Griesheim Chemische Fabrik and the Metallgesellschaft, of Frankfurt-am-Main.

The works of the Vereinigte Aluminiumwerke

were added to in later years by the construction of the Erftwerk A.G. factory, and the Inn Aluminium Works. In 1933 the three works of the Erftwerk, the Innwerk and the Lautawerke represented a total capital value of 24,000,000 marks.

The Lauta Aluminium Works

In the accompanying engraving we reproduce a general view of the Lauta Aluminium Works which, on the night of September 22nd and the morning of September 23rd, were the subject of an attack by machines of the Bomber Command, and suffered severe damage. The works can for the purpose of our article be divided into the following sections: first, the large power station of the Elektrowerke A.G., which supplies the power for the factory, the generator works for producing from brown coal the supply of power gas used in the aluminium works and the foundry, the aluminium works itself and the casting foundry, besides a number of auxiliary works.

The power station of the Elektrowerke at Lauta the large transformer station for the stepping down of the high-tension supply from the Elektrowerke turbines, to the pressure of 500 volts, used in the factory process. The station has a number of transformers and also motor generators. In addition to the large section of the works containing the electrolysers for the production of the metal, there is a large and well-equipped foundry, in which the aluminium is cast into ingots and bars, after which it receives further treatment by rolling, pressing and forging. Alongside the main Lauta factory there is an auxiliary plant for the production of ferro-vanadium. It is worked in conjunction with the Otavi Mine and Railway Company, and before the present war was engaged in the production of vanadic acid from an African ore; and from the acid ferro-vanadium was produced by an alumino-chemical process and was finally reduced to a product containing up to 96 per cent. of vanadium.

When the power station and aluminium works were constructed the village of Lauta had no suit-

Map Showing Objectives Bombed in Germany

was referred to in our recent article on the Berlin electricity undertaking as one of the stations from which a supply of bulk current was obtained. The turbine sets in 1935 consisted of one 16,000-kVA set, one of 20,000 kVA capacity, and one of 30,000 kVA, and possibly since that date the size of the station has been increased. The generator works contains a modern installation of gas generating plant designed to utilise the local brown coal which is obtained from the Erika Mine of the Ilse Bergbau A.G., which is situated at a distance of about 3 kiloms. from the Lauta factory. The aluminium factory is designed to operate on a modified Löwig or Penikoff process, utilising soda or sodium sulphate in the reduction of the Hungarian bauxite to an aluminium salt, from which the metal is obtained by electrolysis. It is of interest to record that from the process an important by-product is obtained, which is widely used in Germany for the purification of gas. It consists of a red mud, containing colloidal iron oxide and iron hydroxide in a useful form for gas purification.

Another important part of the factory consists of able accommodation for the large number of workpeople, and two large housing estates were built, where the officials and workpeople engaged in the industry have their homes. Enough has been said to indicate that the Lauta works is, from the point of view of the Royal Air Force, an important target.

In conclusion, a short reference may be made to the other undertakings of the Vereinigte Aluminiumwerke A.G. at Erft and on the River Inn. At the Erftwerke there is also a large transformer station, in which the 10,000-volt supply obtained from the high-tension network of the Rheinisch-Westphallen Company is stepped down from the supply pressure to 5000 volts by transformers and to 500 and 250 volts required by the aluminium factory by motor generators. Besides the aluminium works there is similar electrolytic plant to that used in the other works of the company; there is also a factory for the production and manufacture of aluminium foil carried on by the Rheinisch-Blechmetal A.G. In this factory there is plant installed to roll the aluminium produced at the Erftwerke into thin aluminium foil. At the Innwerke the 33,000-volt supply obtained from the supply company is used to operate the factory after it has been stepped down to D.C. current for the electrolytic plant. In all the works mentioned above there is produced not only pure aluminium, but other aluminium alloys, such as silumin.

As early as 1934 the German aluminium industry was producing well over 30,000 tons of metal per annum, and in the following year a record production was achieved. About that time it was decided that the three largest undertakings of the Vereinigte Aluminiumwerke A.G. at Lauta, Erft and Bitterfeld should be enlarged so as to deal with a possible production of 60,000 to 70,000 tons of aluminium and its alloys per year. In the last few years, with the establishment and growth of the German Air Force, there is no doubt that the aluminium production of Germany has been further increased. Any reference to these important works would be incomplete without some mention of the carefully planned programme of works and industrial research which has been carried out by the company and was always a feature of the company's exhibits at the Leipzig Fairs and the Düsseldorf Exhibition. Large chemical, testing and electrical research laboratories were built and equipped with the most modern appliances for the investigation of process improvements, factory production and the problems met with in industry in the application and working of aluminium alloys. The metallurgical laboratories were established at the Erftwerke, while at Lauta attention was paid to the testing of materials. Work was also done on the best casting condition for aluminium and its various alloys, particularly as affecting industrial problems. In the electrotechnical department of the laboratories, which are also at the Lauta works, research work was carried out on the use of aluminium alloys for overhead high-tension lines, dealing with such questions as the swing of aluminium lines, the problem of resistance and the production of suitable protective coverings, such as Elexol. For the carrying out of this programme of research a well-equipped laboratory with various sources of current supply was built.

SOUTH AFRICAN ORDERS FOR AMERICA

The Union's war requirements and the fact that Great Britain is unable, owing to her own demands, to supply them all, has resulted in the Union having appointed its own armaments-buying Commission in the United States, working in close co-operation with the British Commission. Mr. G. H. Swingler is the Chairman. Mr. Swingler is the electrical engineer of the City of Cape Town, and, in addition to managing the municipality's power station, is the local manager of the Electricity Supply Commission, in respect of its power station at "Paarden Island," situated a little over a mile from Cape Town. This arrangement makes for economy and efficiency as the two power stations are interconnected and the outputs pooled. Mr. Swingler is chairman of the buying Commission and represents the Director-General of War Supplies, and he is accompanied by military and commercial representatives. The Commission has already begun operations in America and is buying armaments, munitions, plant, and other war material, including military aeroplanes. Mr. Cameron Mitchell, of Johannesburg, has gone to England as liaison officer for the Director-General of War Supplies.

A Union War Supplies Commission has also been established in East Africa under the chairmanship of Mr. P. V. Gawith, of Pretoria, who has been given the rank of Colonel. It is also announced that the Union of South Africa is taking part in a conference arranged with other Dominion Governments for the development of Commonwealth resources east of Suez.

The production of war supplies is regarded in the Union as closely interlocked with the general industrial activities of the country and the two must march in step. It is necessary that the other essential everyday demands of the country should also be met, as far as is consistent with the policy of giving priority to war supplies work. Thus, men who are apparently carrying on their normal work are also contributing, albeit indirectly, to the Union's war effort. The gold mining industry, for instance, is regarded in every essential as a key industry, which contributes in a most important degree to the war effort of the Union. Many men in other industries are also actively engaged, without realising it, on work which is a vital part of the war effort. They are the men who are producing small parts of weapons which are being assembled in vast quantities elsewhere or are making parts of machines and machine tools or gauges for the munitions factories which are being brought into existence throughout the Union.

Conversion of Petrol Vehicles to Operate on Town Gas*

By E. A. C. CHAMBERLAIN, Ph.D., D.I.C.

(*Continued from pages 240, October 11th*)

Gas Bag Capacity

From the figures obtained on the Austin 16/6 engine the ratio of the thermal efficiencies on No. 3 petrol and gas are :—

Thermal efficiency gas/thermal efficiency petrol

$$=\frac{18\cdot5}{19\cdot4}=0\cdot954.$$

The calorific value of No. 3 petrol is given as 1·505 therms per gallon. The number of cubic feet of gas equivalent to a gallon of petrol is therefore approximately

$$\frac{1\cdot505}{0\cdot954}\times200=315 \text{ cubic feet.}$$

In practice it is desirable that at least 20 miles should be covered with one fill, and the following figures indicate what bag capacities are required for various horsepower vehicles to give this mileage :—

H.P.	Approximate m.p.g.	Approximate capacity of bag, cub. ft., to give 20 miles.
8	40	150
10	36	175
12	24	260
16	20	300
20	18	350

It should be mentioned that it is the practice not to exceed a pressure of 2in. water gauge (0·072 lb. per square inch) inside the gas bag, and a pressure cut-off should be fitted in the supply pipe at the filling station to shut off the gas when this pressure is reached. This precaution is taken in order to avoid strain on the bag fabric and to prevent the over-enrichment of the air/gas mixture which would occur while the gas was under pressure just after filling.

The following data obtained during tests show the most convenient size bag that can be fitted to various makes of vehicle and the mileage that can be expected per bag :—

Vehicle.	H.P.	Type of crate.	Capacity, cub. ft.	Miles per fill.	Miles per 300 cub. ft.
Ford saloon... ...	8	Box	170	23	40·6
Morris saloon ...	8	Collapsible	150	15	30·0
Ford van	8	Box	180	25	41·5
Austin saloon ...	10	Box	220	21·6	30·0
Austin saloon ...	12	Box	210	18·9	27·0
Morris van	12	Box	240	20	25·0
Morris van	14	Collapsible	270	20	22·2
Austin saloon ...	18	Metal tube	190	13	20·5
Bedford van ...	18	Collapsible	500	17	10·2
Ford van	24	Box	470	21	13·4
Studebaker saloon	27	Box	500	22·5	13·5
Dennis	30	Box	280	9	9·6
Thornycroft ...	35	Box	500	19	11·4

Resistance Due to Wind Pressure on the Front of the Bag.—The pressure on a flat surface exposed at right angles to the wind direction is given by the equation

$$P=\frac{5\,G_a\,V^2}{8\,g}$$

P = pressure in lb. per square foot.
G_a = weight of 1 cubic foot of air at N.T.P. = 0·0807 lb.
V = velocity in feet per second.
g = gravitational constant, 32·2.

The total pressure in lb. on a flat surface A square feet in area travelling at S miles per hour in a still atmosphere will therefore be

$$P=A\times0\cdot00334\times S^2.$$

Hence the total horsepower required to overcome the wind resistance at S m.p.h. is given by

$$\text{H.P.}=A\times0\cdot00334\times S^2\times0\cdot00267\,S$$
$$=A\times S^3\times8\cdot9\times10^{-6}$$

Taking as an example a bag of 250 cubic feet capacity on a vehicle 12ft. long, the frontal cross section will be 21 square feet. The horsepower required to overcome the resistance offered by this area at speeds up to 60 m.p.h. in still air is given by the curve (Fig. 1). It is obvious that this energy expenditure will be modified by atmospheric wind conditions and by the fact that the bag does not offer a plane surface and will rapidly become deflated at the front. It is clear, however, that apart from the disadvantages already mentioned of boxing-in the front of the crate, such a procedure involves a permanent wind resistance not diminished by the collapse of the bag. This resistance will not only be serious when operating on gas, when the power output of the engine is already lower than on petrol, but will also react on performance and consumption with petrol.

Gas Connections.—It is not always realised that high gas rates are involved when a conversion is made. For example, an engine developing 20 B.H.P. requires between 500 and 600 cubic feet of gas an hour. It is essential that the pressure at the carburetter shall not fall appreciably or the carburetter will be starved. For this reason adequate size connections must always be made. It is suggested that the internal diameter of all connections should not be less than 1¼in. right up to the main cock on the inlet of the carburetter.

Filling Valve.—Fig. 2 shows the valve approved by the Industrial Gas Centres Committee to be

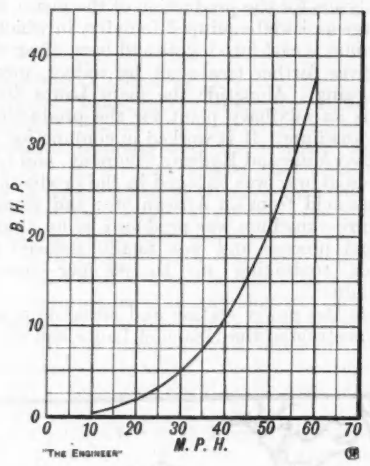


Fig. 1

mounted on all vehicles fitted with gas bags. The connection to the bag is made at A ; filling takes place through the screw connection B, and the non-return valve C ; D is the outlet to the carburetter. By adopting this valve as standard throughout the country it is possible to refill the bag at any filling

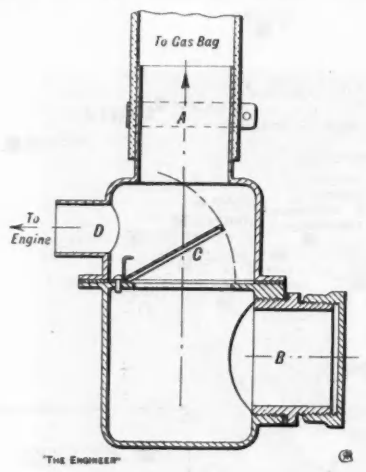


Fig. 2—*I.G.C.C. Filling Valve for Gas Bags*

station without difficulties arising owing to different pipe sizes.

Gas Bag Fabrics

When conversions were first undertaken, the choice of the gas bag material was left to the bag manufacturers. During the past twelve months, however, it has been possible to devise tests, the results of which are confirmed by practical experience, and it is now possible to indicate what type of material will give the best service. Before any tests on fabrics were undertaken, inquiries were made of the British Standards Institution, the British Rubber Manufacturers' Research Association, the Cotton Research Association, and the Manchester Chamber of Commerce Testing House about agreed methods of test applicable to this problem. The only relevant B.S. specification appears to be B.S.S. 2 F41—1930, which deals with rubber-proofed materials for aircraft and describes a hydrogen permeability test. This test is designed for balloon fabrics, and is not directly applicable to gas bags. Moreover, it involves a gravimetric test, and is therefore slow. The British Rubber Research Association gave useful advice on mechanical tests, and suggested that natural ageing by exposure to weather was better than artificial methods, such as irradiation by ultra-violet light. The Cotton Research Association was not able to suggest a complete abrasion test, but from the information given a test has been devised. The test methods adopted as standard are as follows :—

(1) *Tensile Strength.*—Specimens are first conditioned for twelve hours preceding the test at 65 deg. to 70 deg. Fah., 65 to 70 per cent. R.H., then extended at a constant rate of 12in. per minute.

(2) *Tearing.*—Specimens conditioned as before are placed in the tensile testing machine and a small nick made in the edge of the material, the load at a constant extension rate of 12in. per minute is then measured. The test is made in two directions at right angles.

(3) *Abrasion.*—A 1in. strip is held over a stationary former and abraded by a 13 oz. grey cotton canvas of unsized yarn, under a load of 0·5 lb. The traverse is 1260in. per minute, and a total traverse of 28,000in. is made, changing the abrasive material every 7000in.

Where samples have different surfaces, the coarser surface is tested. After abrasion the samples are conditioned as in test (1) and the tensile strength once more measured.

(4) *Stripping.*—The time to strip 1in. on a 1in. wide specimen under a constant load of 4 lb. is measured.

(5) *Weathering.*—Samples are exposed for one month (720 hours) held by wooden pegs on a cord suspended on the roof of Watson House. After weathering they are given visual inspection, tensile strength, stripping and permeability tests.

(6) *Permeability.*—The apparatus developed for this test is shown in Fig. 3. Its object is to determine the pressure decay curve under constant volume

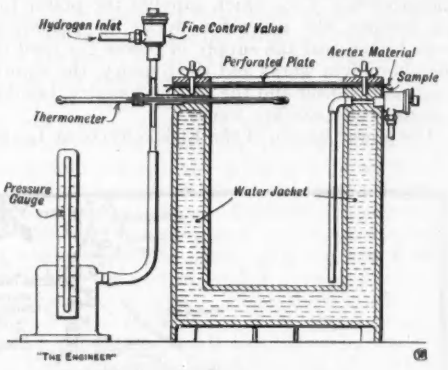


Fig. 3—*Diffusion Cell for Testing Gas Bag Fabric*

conditions. The measurement is made by clamping over the open end of the cell a specimen of the fabric. Constant volume conditions are ensured, supporting the fabric with a sheet of perforated metal, the two being separated by a sheet of "Aertex" material to allow free outward diffusion. The seal between the fabric and the cell is made with lanolin, and the valves used are all neoprene seated with flat faces. The whole cell is heavily built, and has a water jacket to increase the thermal capacity and eliminate the effect of small temperature variations in the test room, which is itself thermostatically controlled. Pressure drop, afterwards corrected for barometric variations, is read on a single column gauge using mineral sperm oil as the indicating liquid. Commercial hydrogen is used for the tests, this being drawn straight from a cylinder. The use of coal gas would have brought in complications owing to changes in gas quality, but check tests have been made. Two typical curves (Fig. 4) are given showing A a typical diffusion pressure decay curve and B a discharge

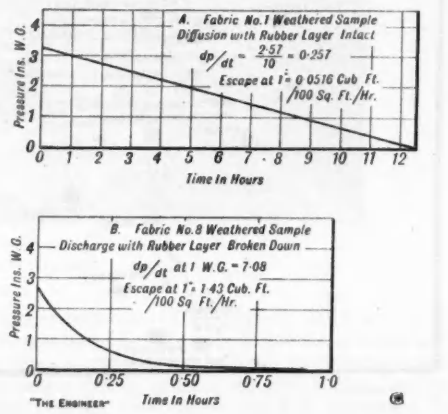

A. Fabric No.1 Weathered Sample
Diffusion with Rubber Layer Intact
dp/dt = 2·57/10 = 0·257
Escape at 1" = 0·0516 Cub. Ft. /100 Sq. Ft./Hr.
Pressure Ins. W.G.
Time in Hours
B. Fabric No.8 Weathered Sample
Discharge with Rubber Layer Broken Down
dp/dt at 1 W.G. = 7·08
Escape at 1" = 1·43 Cub. Ft. /100 Sq. Ft./Hr.
"The Engineer"

Fig. 4—*Tests on Fabrics. Typical Pressure Decay Curves after Weathering*

curve when the rubber has been broken down by weathering. The results of tests are expressed as loss in cubic feet per 100 square feet per hour.

Calculation of Permeability from Test Readings.—

V = Total volume of the cell, including pressure gauge connections, &c.
A = exposed area of fabric.
X = rate of escape, cubic feet per 100 square feet per hour.
$d\,p/d\,t$ = slope of the pressure decay curve, taken at the reference pressure of 1in., p measured in inches w.g., t = time in hours.
P = atmospheric pressure in inches w.g.

$$\text{Then } X=\frac{100\,V\,d\,p}{A.P.\,d\,t}.$$

Test Results.—In general, the test after weathering provides the best guide as to the suitability of a material, and it may be said that a material after weathering should have a permeability not greater than X = 0·1 cubic foot per 100 square feet per hour, and the tensile strength should not have fallen below 40 lb. per square inch width in either direction.

It has been found that the most satisfactory

* Institute of Fuel : Abstract.

materials are those having a rubber layer sandwiched between cotton fabric material. Calendered materials are unsatisfactory, since they tend to peel and crack. Single-proof materials can be satisfactory, provided that the rubber is applied to a thoroughly scoured surface of a suitable backing material such as double weft and warp Wigan or heavy duck. A vulcanised rubberproof is superior in wearing qualities to a pure rubberproof. When making the bag, all seams should be double sewn and taped. The proofing must be on the inside of the bag in contact with the gas.

Two typical test results are given: No. 1 a satisfactory material, and No. 8 a reject :—

Description.	Material No. 1. Rubber sandwich Wigan.	Material No. 8. Single ply calendered.
Weight of 1 sq. yd.	1·72 lb.	0·76 lb.
Tensile strength before weathering, lb./in. width	88 (W) 76 (A)	51 (W) 42 (A)
Tensile strength after weathering, lb./in. width	88 (W) 71 (A)	38 (W) 36 (A)
Permeability after weathering, cub. ft./100 sq. ft./hour	0·052	1·43
Reduction in tensile strength after abrasion	2·5% (W) 12% (A)	23% (W) Nil (A)
Stripping time to strip 1in., 1in. wide	105 sec.	5 sec.

Swelling.—Final tests to determine the effect of contact with town gas on the fabrics have not been decided upon. Preliminary results obtained by hanging samples in a continuous gas stream indicate that weathering is a more important factor in fabric deterioration.

Vehicle Performance on Gas

Engine performance on town gas has already been discussed, and the influence of the gas container and auxiliary equipment has been indicated; besides these factors there are the host of details in design that give rise to the individuality of the many makes of vehicle on the roads to-day. It is these last considerations which necessitate individual treatment for each conversion. From experience on many types of private and commercial vehicles ranging from a two-cylinder, two-stroke delivery van to an American six-cylinder, 26 H.P. saloon car, it can be asserted that, provided a vehicle is in a reasonably good mechanical condition, satisfactory results after conversion can be achieved. It must be realised, however, that marked peculiarities in design call for special attention when carrying out a conversion, and it is hoped that these notes have provided a guide to the factors that must be considered. As an indication of the results which may be expected after conversion, two test results of our own are given in detail, one of a Morris 12/4 delivery van, and the other of an Austin 10/4 saloon :

Test on Morris 12/4 Van, No. 917

Engine, four-cylinder Morris; sparking plugs, Champion L.10, 15/1000in. gap; carburetter, G.L.C. No. 1, fitted into S.U. petrol carburetter air inlet; bag capacity, 250 cubic feet; crate, low box type.

Acceleration and performance.	Petrol—gas bag full.	Gas.
Test hill, 1 in 13	2nd gear	2nd gear
Acceleration, 0–25 m.p.h.	9·3 sec.	12·3 sec.
Maximum speed, north, south	40 m.p.h.	38 m.p.h.
Maximum speed, south, north	41 m.p.h.	41 m.p.h.
Mean speed	40·5 m.p.h.	39·5 m.p.h.
Consumption	20 m.p.g.	19 miles/250 cub. ft.
Cruising speed	30–35 m.p.h.	28–32 m.p.h.

Test on Austin 10 Saloon

Engine, four-cylinder Austin; sparking plugs, Lodge C.14; carburetter, G.L.C. No. 1, fitted into air intake of Zenith down-draught petrol carburetter; bag capacity, 220 cubic feet; crate, low box type.

Acceleration and performance.	Petrol (bag full).	Gas.
Test hill, 1 in 13	2nd gear	2nd gear
Acceleration, 0–25 m.p.h.	14 sec.	14·6 sec.
Maximum speed, north, south	48 m.p.h.	45 m.p.h.
Maximum speed, south, north	39 m.p.h.	32 m.p.h.
Mean speed	43·5 m.p.h.	38·5 m.p.h.
Consumption	28–30 m.p.g.	21–22 miles/220 cub. ft.
Cruising speed	30–35 m.p.h.	30 m.p.h.

The following independent test was made at Brooklands on a Standard 14 H.P. car :—

Engine, four-cylinder Standard; sparking plugs, K.L.G., F.70 X; carburetter, G.L.C. No. 1, tee fitting into induction manifold Solex petrol carburetter; bag capacity, 200 cubic feet; crate, Walsh collapsible.

Acceleration and performance.	Petrol-gas container inflated.	Gas.
Test hill, 1 in 4	1st gear	1st gear
Acceleration, 10–30 m.p.h.	9·4 sec.	14·2 sec.
Maximum speed	66 m.p.h.	55 m.p.h.
Consumption	18 m.p.g.	18 miles/200 cub. ft.

The following analysis, for which the author has to thank Mr. V. H. Prodham, manager of the transport section of the Gas Light and Coke Company, is given as an illustration of the average performance before and after conversion of a fleet of light delivery vans :—

Morris 12/4 Vans Operating on Express Delivery Service

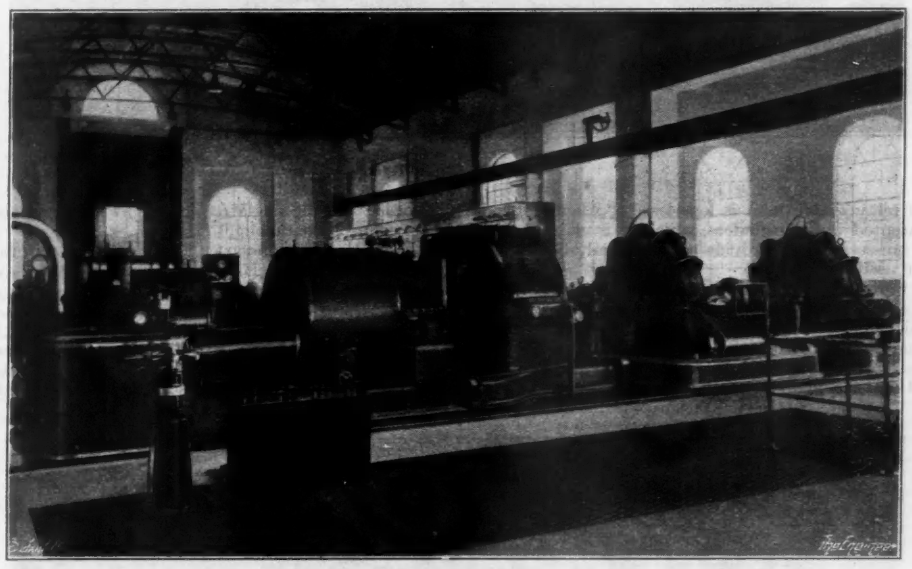
Number of vans converted	25
Estimated cost per conversion	£32.
Total mileage all vehicles before and after conversion per month	26,000
Average mileage per month per vehicle	1,040
Average petrol consumption per vehicle per month before conversion	43 gallons
Average gas consumption per vehicle per month after conversion	67 therms

To the end of July, 1940, the following vehicles have been converted :—32 light vans, 2 lorries below 2 tons, 7 lorries above 2 tons, 26 private cars up to 10 H.P., 3 private cars above 10 H.P.

Total gas consumption, all vehicles, per month, cubic feet	695,000
Total petrol consumption prior to conversion, per month, gallons	2,513
Total gas consumption all vehicles, January–June, 1940, cubic feet	2,105,323
Assuming 300 cubic feet of gas is equivalent to 1 gallon of petrol, the total saving of petrol in six months has been, gallons	7,000

Steam Turbine Driven Pump for Rand Water Board

In South Africa the Rand Water Board supplies water to a considerable area from large central pumping stations and units have increased in size progressively from 1000 H.P. to the latest installation which has just been completed at Vereeniging, a unit capable of a continuous output of 7000 B.H.P., if required. It is illustrated by a number of accompanying engravings. The plant is steam turbine driven. It was made by W. H. Allen, Sons and Co., Ltd., of Bedford.



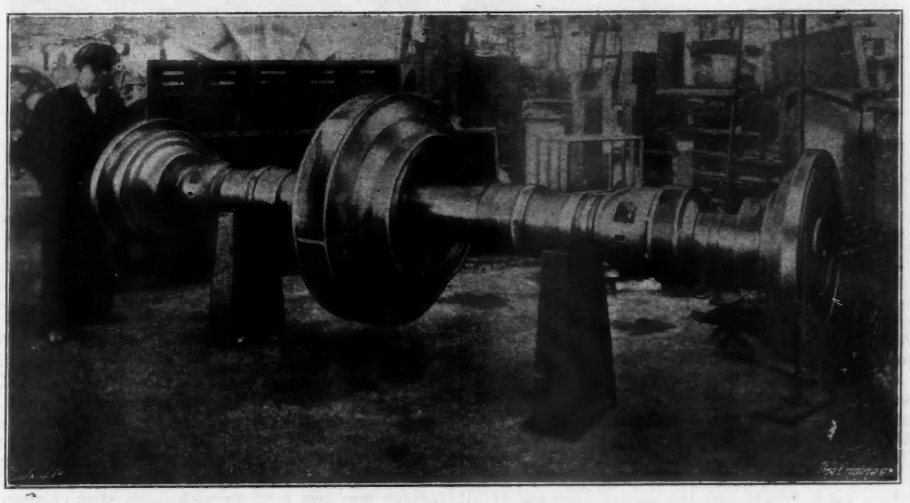
7000 B.H.P. Pumping Unit

The pump unit consists of two single-stage centrifugal pumps operating in series and designed for a normal output of 45 million gallons per day, delivered against a total head of 530ft., the pump running at a speed of 700 r.p.m. By lowering the speed to 650 r.p.m. 35 m.g.p.d. is delivered efficiently against a total head of 480ft., and by raising the speed to 735 r.p.m. a maximum continuous output of 50 m.g.p.d. is obtainable against a total head of 560ft. The efficiency of the pump at normal duty is 87 per cent., at minimum duty 85·5 per cent., and at maximum duty 86 per cent.

The pump casings are made of cast iron, heavily ribbed and split on the horizontal centre line with branches on the bottom half of the pump casing so that inspection or repairs may be made to the internal working parts without disturbing pipe joints. The pump casings were hydraulically tested to a pressure of 500 lb. per square inch. Bronze double suction impellers are keyed to a 9in. diameter forged steel shaft encased with renewable bronze sleeves in the water spaces and stuffing-boxes. Each pump shaft is supported in a spherically seated white metal lined bearing lubricated under pressure from the main turbine oil supply, and oil throwers are provided on the shaft with catchers to prevent leakage from the bearings. The first-stage pump is connected to the second-stage pump by a flexible coupling and another flexible coupling is used to connect the slow-speed gear shaft to the first-stage pump. In the housing of the outer bearing of the second-stage pump there is incorporated a Michell thrust bearing. The usual stuffing-boxes, lantern rings and water seals are fitted. Renewable rings are fitted to the impeller cheek and the pump casing so that any leakage which may occur due to wear may be adjusted. The first-stage pump is connected to the second-stage pump by a cross-over pipe, which is underneath the pump assembly.

The two-stage design was adopted in preference to a single stage because the latter arrangement would have involved large heavy castings to withstand the relatively high test pressure of 500 lb. per square inch and in addition the pump would have been more difficult to dismantle for inspection.

The turbine is a two-cylinder machine, having a maximum continuous rating of 7000 B.H.P. at 4200 r.p.m., and it operates with steam at a pressure of 210 lb. per square inch and a total temperature of 600 deg. at the turbine stop valve. The high-pressure rotor has eleven Rateau wheels, approximately 19½in. in diameter, and the low-pressure rotor a similar number, varying in diameter from 30in. to 34in. By splitting up the unit into two cylinders it has been possible to produce rotors with running speeds well below the first critical. The economical normal duty power of 5770 B.H.P. is obtained when running on all



Pump Impeller and Shaft

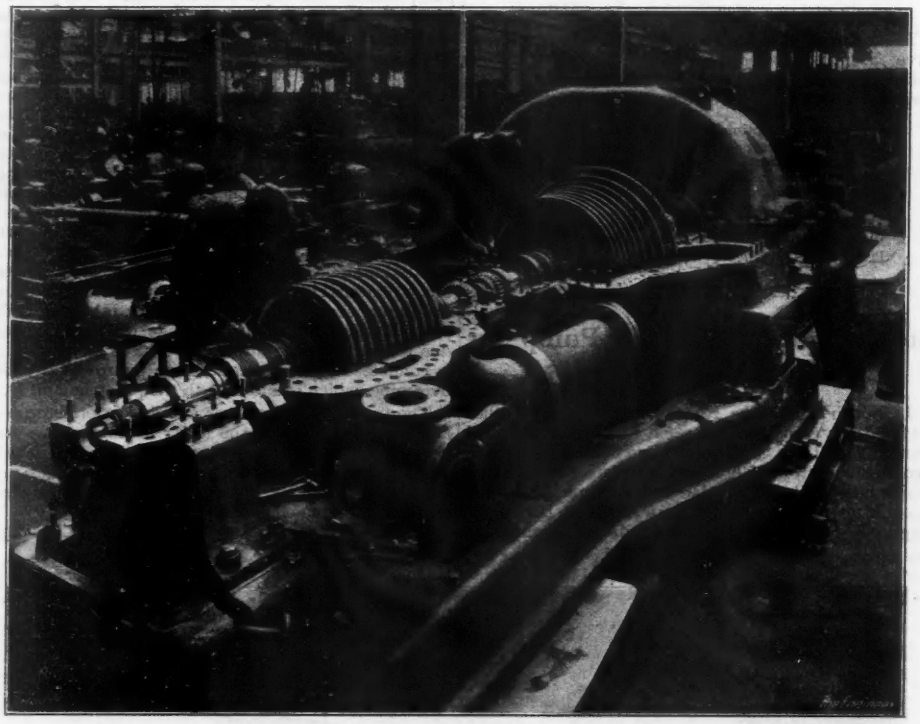
the stages, and the maximum pump load of 6870 B.H.P. is met by admitting steam into the third Rateau stage through a by-pass. The high-pressure turbine casing is made entirely of steel as a one-piece casing with no vertical joint. The high-pressure end of the low-pressure casing is also of cast steel and the exhaust end of cast iron. The speed governor is a centrifugal governor used in conjunction with an oil relay system and is leverless. "Allen-McLeod" patented water excluders, which, it is claimed, make it unnecessary to provide a centrifugal oil separator, are used.

Forced lubrication is applied to the turbine bearings, gear bearings and pump bearings, and for this purpose two pumps are included in the assembly. One is driven from the turbine rotor shaft through gearing. It is a double compartment pump, providing oil under a pressure of 10 lb. per square inch for the bearings and 40 lb. per square inch for the oil relay gear.

An auxiliary steam turbine driven pump, which has a capacity of 25 per cent. in excess of the main pump, is automatically put into operation if the main pump fails.

The labyrinth steam glands have clearances so fine that it is essential to maintain the position of the turbine rotor relative to the casing constant at all temperatures.

Provision of a kinematic support at the steam end of the turbine effects this purpose. Inclined faces form the connection between the casing and pedestal, so that any expansion due to temperature causes, in addition to radial displacement, a downward displacement. The centre line of the casing is thus maintained undisturbed in space and the shaft clearances are kept constant over a wide range of temperature.



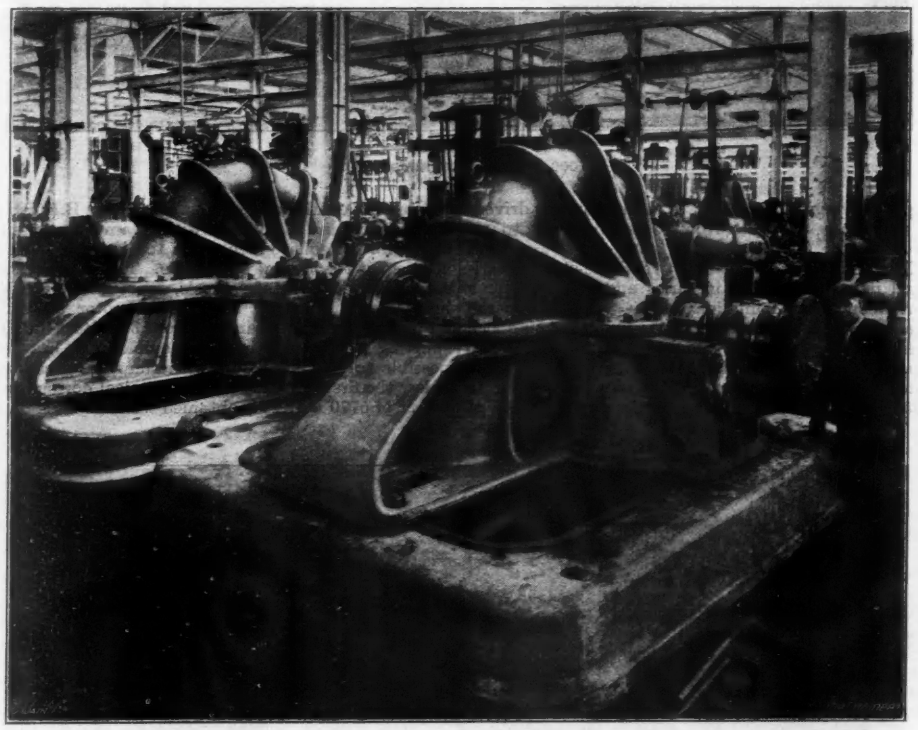
ERECTION OF TURBINE

Double helical, single reduction, forced lubricated gears connect the turbine to the pumps.

The single-flow condenser is designed to maintain a vacuum of 28·3in. Hg. (barometer 30in.) at maximum rating when supplied with circulating water at a temperature of 82 deg. Fah. It has a surface of 7600 square feet.

All the water pumped by the main pumps is passed through the condensers. At normal duty the friction loss through the condenser is 2·65ft., at minimum duty 1·61ft., and at maximum duty 3·3ft. Two vertical extraction pumps are installed, one of which is motor driven and operates continuously, and the other driven by a steam turbine which is held in reserve. The guaranteed steam consumption per W.H.P. at normal duty is 9·26 lb.

In view of the urgency of delivery it was not found possible to test the complete unit, although the turbine was run light to make sure that clearances were satisfactory before the plant was dismantled for despatch. Upon completion of erection at site, so we are informed by the makers, the plant was started up immediately and set to work on commercial load without any need for preliminary adjustment runs.



PUMPS UNDER ERECTION AT WORKS

The Traffic and Ventilation Control Systems of the Bingham-Copperfield Tunnel

A TUNNEL, 6975ft. in length, for vehicular and pedestrian traffic, has recently been constructed by the Utah Construction Company at Bingham Canyon, Utah, to facilitate traffic between Bingham and Copperfield, and in particular to meet the growing output of the Utah Copper Company's open-cut mine. The tunnel has a full-arched back with straight walls, and is concrete-lined throughout its length. The width of the tunnel is 16ft. 4in., and from the road surface to the crown of the arched roof it measures 18ft. 2in. On one side is a side walk elevated 3ft. above the road surface, and having below it a flume for drainage, sewage, &c. This side walk occupies an overall width of 4ft. 4in., so that the net width of the vehicular roadway is only 12ft. The tunnel is curved in plan, but in elevation it rises with a uniform gradient, the Copperfield portal being 450ft. higher than the Bingham portal.

The dimensions of the tunnel permit one-way traffic only. An automatic traffic control system has therefore been installed. The following particulars of this system and also of the ventilation arrangements for the tunnel have been taken from a circular describing the general construction of the tunnel issued by the Bureau of Mines, United States Department of the Interior.

Vehicular Traffic Control

The control station is at the north or Bingham portal. Power for operating both the traffic and ventilation systems is supplied by a single-phase, 2300-volt circuit. Transformers reduce this voltage to 115 volts for the lines leading to the traffic control panel and motor-driven timing relay switches. The alternating current is converted to direct current by copper oxide rectifiers before going to a photo-cell circuit used in the system. All timing relay circuits are interlocked between the two portals, so that when the timing relay at one end is energised a green light shows at that portal while a red light shows at the other. This light remains green for 2 min. 10 sec., after which the relay at the other end is energised. This causes a red light to show at each portal and the controls are shifted to an electric counting equipment.

The counting units are the same at each portal. Each unit consists of two photo-electric cells, connected through a system of selective switches. These electric eye units are actuated by an object interrupting a beam of light, and the two cell units are necessary to prevent the counting of small objects. Cars with a space between the cab and body, such as dump trucks, would be counted as two cars if only one cell were used. The light beams of both cells must be broken simultaneously before the counting equipment will register. As traffic begins to flow in one direction the electric eyes count out a pre-set number of vehicles. Each interruption is registered through the selector switches. This causes a difference in potential to be built up, which is only equalised as the photo-electric cells at the opposite portal count out an equal number of vehicles. As the last car passes out of the tunnel the controls shift to the opposite portal, energising that time-delay switch; the colour of the traffic lights is reversed, and traffic proceeds in the opposite direction. The re-set relays act each time the tunnel is clear of traffic by re-setting the time delay. Contactors prevent the time delay from taking control until the tunnel has been cleared, and additional time-delay relays are provided to prevent the green light at each portal from being turned on until the red light has been on a definite length of time. When traffic in the tunnel becomes greater than is predetermined, the red lights at both portals are turned on.

The current that passes through the selector switches also goes through the alarm relay circuits. These relays are set for 15 min., so that if the potential between the selector switches is not equalised in this time a bell is sounded in the traffic-control station. This indicates that one or more vehicles remain in the tunnel, and must be cleared before traffic can proceed again. As a safety measure for power interruptions, a 6-volt battery circuit connected to a 115-volt control circuit through no-voltage contactors flashes a red stop light at each portal until power is restored. Control of the traffic lights may be changed from automatic to manual operation by means of a simple transfer switch.

Ventilation Control

As the tunnel was constructed to accommodate both vehicular and pedestrian traffic, provision has been made to control accumulation of carbon monoxide gas emitted from automobile exhausts. Natural ventilation would not be effective, as atmospheric pressure varies at different seasons of the year, and often is nearly equal at both portals. Only during the winter months would there be an air

current of velocity adequate to clear the tunnel of fumes. Four control rooms are situated in recesses in the tunnel. The latter are 300ft. and 1900ft. from each portal. Three kVA transformers reduce the 2300 voltage to 115 volts for the continuous recording and sampling equipment.

Air is constantly being pulled from the tunnel to each of the control rooms at the rate of 0·5 cubic foot a minute by a Leiman positive pressure blower. This blower is directly connected to a ½ H.P., 115-volt motor. The air is cleaned in passing through a charcoal canister, dehydrated through a calcium chloride tower, and delivered to a Hopcalite cell. This cell is immersed in boiling water to maintain a constant sensitivity for recording purposes. The cell contains a thermo-couple packed in dry Hopcalite. The Hopcalite is very sensitive to carbon monoxide, and heats at the rate of 0·6 deg. Cent. per one-hundredth part of carbon monoxide per one ten-thousandth part of air. This temperature rise, acting on the thermo-couple, sets up a minute electric circuit, which is transmitted to a recording potentiometer. The potentiometer gives a continuous record of the concentration of carbon monoxide per 10,000 parts of air. A break contact in the recorder is set to start the exhaust equipment when the carbon monoxide concentration reaches 3·5 parts to 10,000. This break contact de-energises the traffic control coils at the two portals, allowing them to close by gravity. The closed circuit at the lower portal sets the traffic light to red while the closed circuit at the upper portal starts a 440-volt fan motor and closes a steel roller door installed to prevent a short circuit of air. The door closes 1 min. after the fan is started. The exhaust fan is operated at 600 r.p.m., and has a capacity of 150,000 cubic feet a minute until the carbon monoxide concentration is reduced to 2·5 parts in 10,000. At this point the potentiometer break circuit reverses the above proceeding, and traffic returns to normal.

BRITISH STANDARDS INSTITUTION

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria Street, London, S.W.1. The price of each specification is 2s. 3d. post free, unless otherwise stated.

GAUGES FOR CHECKING LOW VALUES OF ILLUMINATION

BS/ARP 30. A revision of this specification has just been issued. The standard values of illumination have been amended to 0·001, 0·002, 0·02, 0·01, and 0·2 foot-candle, and there is no longer the ambiguity which previously existed between the "nominal" and the "calibration" values. The gauges are designed to give a clear visual indication when one or more of the standard values of illumination are exceeded. These gauges are not intended for measuring the actual value of the illumination at any point, but the scope of the specification B.S. 230—1935 has now been widened so as to provide a portable photometer having a specially low range (0·0005 to 0·02 foot-candle).

Copies of BS/ARP 30 (dated September, 1940) may be obtained from the British Standards Institution, 28, Victoria Street, S.W.1, price 3d. post free, and copies of the addendum to B.S. 230—1935, reference CF (ELG) 6654, may be obtained by sending a stamped addressed envelope to the British Standards Institution.

MOTOR STARTERS AND CONTROLLERS

No. 587. A reprint of B.S. 587, Motor Starters and Controllers, having become necessary, the opportunity has been taken to introduce a few additional clauses, and the specification has therefore been reissued as the 1940 edition. The most important additions are perhaps the mechanical endurance test and an appendix on clearances and creepages for motor control gear. A new definition has also been included, this relating to a "damp and dust-protecting model."

SCREW THREAD GAUGE TOLERANCES

B.S. No. 919. In the foreword to the recently published British Standard 84—1940, "Screw Threads of Whitworth Form," the hope was expressed that this specification would be followed by a supplementary specification giving tolerances for gauges suitable for controlling such screw threads. The British Standards Institution has recently prepared this War Emergency Specification, in collaboration with the Ministry of Supply and in co-operation with the National Physical Laboratory, and the principal gauge manufacturers. This specification relates solely to the tolerances on the gauges and does not deal with the design or dimensions of the gauges themselves in regard to which a further specification is in course of preparation. The principal object underlying the preparation of this War Emergency Specification has been to make some adjustment of the well-known tables published by the National Physical Laboratory. Some extra latitude is allowed in the tolerances on the gauges which will tend to facilitate gauge manufacture, whilst at the same time the gauge manufacturers will be enabled to keep the simple effective diameter high, and thus increase the useful life of the gauges. This adjustment applies to the go-plug screw gauges. No alterations are being proposed in regard to the tolerances for go-ring screw gauges, as given in the National Physical Laboratory tables, and these latter tables are reproduced unaltered. This new British Standard gives the appropriate tolerances for plug, ring, and calliper gauges for threads of Whitworth and metric form in diameters up to 6in., and for B.A. threads down to No. 7. An appendix to the specification includes some notes regarding the effective diameter equivalents of pitch and angle errors.

Markets, Notes and News

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quantities are f.o.b. steamer

The Scrap Position

The demand for scrap is exceedingly heavy and large tonnages are passing into consumption. In most districts there is still a stringency in supplies of heavy steel scrap, but there seems to be a surplus of other descriptions. The extensive home collection of scrap plus imports led to congestion at the works, and it is only recently that many consumers lifted their embargo upon deliveries. Users, however, are showing more willingness now to take up metal than was the case a few weeks ago, since they are anxious to put by reserves for the winter in case of any interruption in transport. The demand appears to be principally for good heavy steel scrap, mixed iron and steel scrap and heavy wrought iron and machinery metal. There seem to be rather larger supplies of heavy steel turnings than are required. At the same time, scrap merchants have been warned that they should not send unlimited supplies into the works, many of which are still holding good stocks. The present abundance of stocks, however, makes some consumers rather cautious and reluctant to arrange new business, which is inclined to be somewhat quiet. The position has been greatly improved by the imports of considerable quantities of scrap from the United States in addition to the active home collections. In the Midlands, however, there is a noticeably strong demand for heavy melting scrap from the steel works. Business in wrought iron scrap also has improved and good supplies of cast iron scrap are passing to the foundries. The Lancashire ironfoundries are busy and it is suggested that in this district good quantities of cast iron scrap are likely to be discovered when the unoccupied mills and factories in this country are searched for suitable metal.

The Pig Iron Market

The feeling amongst pig iron consumers is that the situation has improved of late, and no doubt some of this satisfaction is due to the fact that licences have been issued for the period to the end of December. Consumers of foundry iron, too, have sent in their claims and have apparently received all the iron they hoped for. On the North-East Coast the production of foundry is comparatively small, and little is provided either for the local foundries or for export. It would seem that the quantities of this description obtainable from the Midlands is sufficient for all requirements, and the local makers are therefore relieved of the necessity of catering for the local foundries. In the Midlands the hopes that were expressed a little time ago that the light castings trade would be given a considerable amount of Government work appear to have been disappointed, and although some of them have obtained contracts, the industry is, on the whole, working at well below capacity. The supplies of high phosphoric iron are quite sufficient to meet all requirements from this source. The heavy engineering industry is a big consumer of foundry iron. Practically all the works are engaged to capacity on some form of war production. This has led to a strong demand for low phosphoric iron and hematite. The chief difficulty which this industry has experienced is that it has not been easy at times to get the special qualities required. It is understood, however, that lately a large tonnage of special ores has been imported. The Control is still averse to stocks being accumulated, and applications for licences are carefully scrutinised. Considerable quantities of foundry iron are going to the Lancashire consumers, chiefly from Derbyshire and Staffordshire. There is some irregularity, however, in the position of the various consumers of this make. The machine tool makers and the heavy electrical engineers are engaged to capacity, but the textile machinists and the light castings makers are not nearly so well employed.

Scotland and the North

There has been no relaxation of the pressure on the Scottish steel works, and with the whole industry operating at high pressure big outputs are being obtained. Supplies of raw materials are reaching the steel works in satisfactory quantities, both from home and overseas sources. All the works are well provided with orders. The demand for joists and sections of all sizes is particularly pressing, although some of the constructional engineers are not so well occupied as they were earlier in the year. The demand from this section of the consuming industries appears to have been more than made up by an expansion in the requirements of other users. For instance, the demand from the shipyards is insistent, and in view of the big programme of naval and mercantile construction in hand is likely to continue so for a long time. The call for re-rollers' sizes of sections has been fully maintained, and now that this branch is receiving better supplies of billets, arrears of deliveries are in many cases being overtaken. Although the situation has improved in several respects, so much of the output is absorbed by Government Departments that finished steel for ordinary commercial purposes is difficult to obtain. Under the revised distribution plan, applications for licences are carefully scrutinised by the Control, and there has been a sharp tightening up in the supplies of steel which may be used for non-essential purposes. Amongst the largest consumers of steel are the heavy engineering establishments, power plant producers, and boiler and tank makers, whilst marine engineers are taking up good quantities. Conditions at the bar iron works are not satisfactory, and most of them have as much work in hand as they care to undertake for the time being. The demand is principally for the better grades of bar iron, but nut and bolt bars are in good request. The sheet makers are fully employed, and their output goes chiefly to satisfy the needs of the Service Departments and other priority consumers. Heavy tonnages are passing to the shipyards and to the tankmakers, chiefly of heavy gauge material. Lancashire consumers are absorbing large quantities of finished steel, and a feature of the demand is the increasing tonnages of high carbon and special steels that are asked for. Business in steel bars is also active, and the producers are experiencing considerable pressure from users. The demand for plates is also heavy, and there is a strong request for forging blooms and billets. The wire-drawing section of the industry is busily employed and is using large tonnages of wire bars.

The Midlands and South Wales

All the Midland steel works are producing at capacity, and at the opening of the fourth delivery period, which began on October 1st, a number of the works had their output already earmarked for the period, without taking into account the new orders they may yet receive in the coming quarter. Pressure upon the steel works from customers anxious to obtain material is unrelaxed, and a large proportion of the production is passing at once into consumption upon Government orders. A particularly heavy demand is being experienced by the plate mills, and although it is said that the situation is not so stringent as a few weeks ago, the position appears to be still a little tight, since shipyards, wagon builders, and boilermakers are all important users. The call for constructional steel also is maintained, although some of the structural steel works are not so well occupied as they were a short while ago. Business in light and medium sections appears to be expanding rather than diminishing, and large quantities are being turned out. The re-rollers are extremely busy, and, as they have received supplies of foreign billets and sheet bars, are reducing some of their arrears in deliveries. This branch of the industry, however, has large orders in hand. The sheet makers also report that the orders on their books amount to a heavy tonnage. The industry has been able to dispose of a certain amount of material for export, but the home demands are so heavy that comparatively little can be allocated for this purpose. The situation in South Wales has not changed much, and whilst production is at a high level, the demand has been maintained so well that the resources of the works are taxed to the utmost. Supplies of sheet and tin-plate bars for the tin-plate industry are limited by the necessity of meeting the demand for steel from other industries, but rather better tonnages have been reaching the tin-plate works of late. The sheet mills are well employed upon Government orders.

Copper and Tin

Considerable interest is taken in the British market in the changed situation in the United States. The demand in that country has been well maintained, largely on account of munition orders. The domestic price, also, has been advanced to 12c. and in some cases producers are asking rather more, although that is the recognised quotation. The export position also has improved, largely on a brisk demand from South American countries. The quotation has been raised to 10·40c., f.a.s., and although it is possible to negotiate business at that level it is not easy, and there do not appear to be any offerings from the producers worth speaking of. Recently inquiries were received from Japan for nearby copper, but it is understood that they did not lead to any business, since the required delivery was not obtainable. It is unlikely that the increase in the price of copper in the United States will affect the British market, since our supplies are principally from Empire countries, and the price is fixed. Consumption here is at an exceedingly high level and practically all the supplies pass into war consumption. There is, however, no difficulty in meeting the full requirements of consumers and in some cases copper has been put into warehouse. . . . Steady conditions have ruled in the tin market, but at the beginning of the present week the tone became a shade easier. The daily turnover on the London Metal Exchange has been moderate and has generally reached between 50 and 100 tons. Business has been quiet, but prices have been steady, since there has been no tendency on the part of holders to offer tin. Users apparently get all the metal they require, and export licences are now more freely issued. This in itself is sufficient to give a firmer tone to the market. The recent weakness in tin appears to have passed and to have been largely due to sales by smelters. These have now ceased and prices have become steadier.

Lead and Spelter

Firm conditions rule in the lead market and in the United States the demand has sharply improved. Prices have advanced to 5¼c., New York. Apparently the stronger tone in the market is due to the expected expansion in home requirements as a result of the rearmament programme. In Great Britain there is a heavy consumption chiefly arising out of war work, but supplies of lead which reach this country, chiefly from Empire sources, are sufficient to meet consumers' full requirements. A certain amount of the metal is also passing to firms engaged in making goods for export. Although no statistics are available it would appear that the lead position is the most satisfactory of any of the non-ferrous metals, from the consumers' standpoint. . . . An active demand prevails in the spelter market and good quantities are being taken up for munitions purposes. There is a particularly heavy demand from the brassmakers and the galvanisers are also using substantial quantities. In the United States the price is firm at 7·25c., East St. Louis, and a certain amount of export business has been done. Japan is understood to have bought some metal, but on terms which made the transactions subject to restrictions imposed by the United States Government.

Magnesite in Rhodesia.—Four blocks of magnesite claims have lately been pegged by the Anglo-American Corporation on Barton Farm, about 8 miles from Gatooma, Rhodesia. Twenty tons of the ore have been mined and sent to Johannesburg for analysis.

Notes and Memoranda

Rail and Road

Sorocobana Railway Electrification.—A note in *The Times* records that the contract for the electrification of the Sorocobana Railway, Brazil, was recently signed. The total amount of the contract is approximately £2,375,000, and American firms, including the General Electric and Westinghouse companies, are sharing in it.

Canadian Expansion.—The Canadian Locomotive Company at Kingston, Ont., is adding three new buildings to its plant. The additions are made necessary by orders for war munitions received by the company, and should be completed early in 1941. When the necessary machinery has been installed, production will involve an increase in the company's staff of more than 500 men.

Essential Services in S.A.—South Africa has taken steps to secure the efficient working of its essential services, such as railways, ports, and harbours, and has brought into being what is called the Essential Services Protection Corps. Control is vested in Defence Headquarters in Pretoria, and the Corps is divided into two main sections, namely, a Railway Regiment and a Roads Regiment.

Railway Money for Planes.—The first railway company to send a cheque for £5000 to the Minister of Aircraft Production for a Spitfire was the Southern Railway. All ranks of Southern railway men and women, from directors to signal-box lads and members of associate companies, have subscribed to this fund. The plane is to be named the "Invicta," after the first engine on the Canterbury and Whitstable Railway in 1830.

Canadian Travel Bureau.—With the object of co-ordinating all Government activities which may have a bearing on tourist traffic in Canada, and also to develop a general tourist policy in the Dominion in co-operation with all existing Federal and Provincial organisations interested in its promotion, an Inter-departmental Committee has been appointed by the Canadian Government under the chairmanship of Colonel V. I. Smart, Deputy Minister of Transport.

Paper as Freight.—Australian Paper Manufacturers, Ltd., now use monthly 600 tons of scrap plywood and soft-wood timber at the mills at Maryvale. This light, but bulky material makes economical loading in standard trucks impossible, only about 5 tons being accommodated in a 16-ton truck. To meet this difficulty, forty-five of the trucks used in the service are to be fitted with a 4ft. high frame in extension of the side and end body plates. The capacity of each truck has been increased 70 per cent. by this method.

Institution of Automobile Engineers.—At the last meeting of the Institution of Automobile Engineers the awards for the session 1939–40 were decided upon. The Crompton Medal for the best paper read before the Senior Centres of the Institution during the session is awarded to Dr. J. S. Clarke (Birmingham Corporation Gas Department) for his paper entitled "The Use of Gas as a Fuel for Motor Vehicles." The Graduates' Prizes for the best papers read before the Graduates' Section during the session are awarded to Mr. J. F. Norwood (Luton Branch) for his paper entitled "Gear Tooth Profiles," second prize (value £8); and to Mr. F. W. Judd (London Branch) for his paper entitled "The Trend in the Development of the Compression-ignition Engine," third prize (value £5). The first Graduates' Prize was not awarded.

Mr. L. F. Loree.—The American papers record the death on September 6th of Mr. L. F. Loree, one of the most eminent of the older American railwaymen. His name will be familiar only to older engineers in this country, for he was born as far back as 1858, and began his railway life with the Pennsylvania in 1877, of which company, when he was only thirty-eight, he was appointed general manager, and a few years later fourth vice-president. In June, 1901, he became president of the Baltimore and Ohio Railroad. In 1907 he filled the same position with the Delaware and Hudson, and retained that position until 1938, when age and illness obliged him to resign. A man of great energy and versatility, he interested himself in all kinds of railway activities and was responsible for the introduction and development of many improvements in signalling, locomotives, and organisation.

Air and Water

S.Y. "Rainbow."—The American yacht "Rainbow," built at a cost of about £100,000 for the defence of the America Cup against Mr. T. O. M. Sopwith's "Endeavour" in 1934, has been bought for scrap for about £3000. She has been stripped of all her fittings preparatory to being reduced to scrap metal at a yard at Boston, U.S.A.

Closed to Navigation.—The St. Lawrence River, between Lake St. Louis and Lake St. Francis, was closed to navigation permanently on September 10th. Water diversion to create power at Beauharnois, which is needed for war work, is the reason for the closing. The diversion project was ratified last session by Parliament.

Two Bequests.—The Institution of Engineers and Shipbuilders in Scotland, the Benevolent Fund of the Institution of Civil Engineers, London, and the Benevolent Fund of the Institution of Mechanical Engineers, London, are each to benefit by £500 under the will of the late Mr. Andrew Thomson Reid, of the North British Locomotive Company, Ltd., Glasgow. Mr. Reid also left £10,000 to the Employment Benefit Fund of his company, and made a large number of other bequests.

Standardising Marine Oil Engines.—An effort is being made to introduce some degree of standardisation in oil engine design for marine work. It is recognised that the number of models built is excessive, and some rationing of types would probably be welcomed by both manufacturers and users. Under ordinary commercial conditions agreement to a general policy would hardly be possible, but in present circumstances an arrangement might be worked out. A committee has been set up, of which Sir James Lithgow is Chairman, having for its object the more effective standardisation of the manufacture of internal combustion machinery.

New Hydro Power Plants.—Ontario hydro engineers are working on plans for the construction of a power plant on the Madawaska River to develop between 150,000 H.P. and 200,000 H.P. Work is also being begun at Big Eddy, above Ragged Rapids, on the Musquash River, where another 10,000 H.P. may be developed.

Area Board, Northern Ireland.—The Ministry of Supply has appointed an Area Board for the Belfast district, with Major Malcolm Speir, manager of the Northern Counties Committee of the London Midland and Scottish Railway Company, as Chairman. The shipbuilding representatives are Mr. D. Alexander, of Harland and Wolff, Ltd., and Mr. H. C. Speirs, of the Confederation of Shipbuilding and Engineering Unions. To arbitrate in industrial disputes and to prevent stoppages, the Northern Ireland Ministry of Labour has appointed a Tribunal, consisting of Mr. Justice Brown, Mr. T. J. Campbell and Mr. D. Lindsay Keir (Vice-Chancellor of Queen's University, Belfast).

Vessels for Soviet Shallow Rivers.—The Commissariat of River Transport of the U.S.S.R. is building a fleet of shallow-draught vessels for use on the small rivers of the Soviet Union. The first batch of these vessels will have a draught of 10in. to 14in. After these have been tested the construction of a large fleet of similar vessels will be undertaken. The construction of a large number of shallow-draught vessels will make it possible to transport millions of tons of freight on shallow rivers. The standard type of these vessels will be a flat-bottomed pontoon, resembling a sledge in front. It will be 26½ft. long, have a beam of 9ft. 10in., and will draw 10½in. of water. Powered by a 21 H.P. gas generator motor, such a vessel will be able to pull three 10-ton barges.

Miscellanea

An Award for Proficiency.—In connection with the evening classes in engineering, to be held at the Northampton Polytechnic, St. John Street, London, E.C., during the winter, students will have an opportunity of competing for a prize, valued at £10, given by Mr. A. C. Pidgen for proficiency in connection with evening instruction in the use of machine tools.

New Oil Gusher at Grozny, U.S.S.R.—The Grozny oil industry has been enriched with a new petroliferous area in the district of Oisungur. A powerful gusher, yielding 250 tons of pure petroleum per day, recently started to spout from well No. 5. The drilling of well No. 7 is expected to be completed shortly. It is expected that further prospecting will confirm the presence of oil in a number of other areas, no less promising than that of Oisungur.

The Honda Prize.—Sir Harold Carpenter, Professor of Metallurgy at the Royal School of Mines, London, was chosen by the Japan Metallurgy Society as winner of the Honda Prize. Candidates for the prize had been recommended from Japan, Sweden, America, Germany and Britain. Sir Harold is the first foreigner to receive the prize. The Honda prize is a gold cup and a supplementary award of about £175. Sir Harold Carpenter died suddenly a few weeks ago.

Lubricating Oil.—The Secretary for Petroleum earnestly requests that distributors and large consumers of lubricating oil, holding both bulk and packed stocks, should use the latter first, thus keeping their bulk stocks in reserve and releasing empty packages. It is important that stocks should be replenished as used. Oil containers should not be used for other purposes or disposed of other than to the supplying company. They should be returned as quickly as possible to the oil company from which they were received.

The Chemical Engineering Group.—The Hon. Secretary of the Chemical Engineering Group of the Society of Chemical Industry informs us that, owing to present circumstances and to the problem of securing suitable accommodation for meetings, to difficulties in transport, and to the fact that authors are unable to promise manuscripts by any particular date, it is impossible to draw up any definite programme. It is hoped that it may be possible to arrange for papers or discussions from time to time, and members will be notified of such meetings. In the forthcoming session the Group will act in the closest co-operation with the Institution of Chemical Engineers, which is suffering under similar disabilities, and any meetings arranged will be held jointly by the two bodies. Advance proofs of papers, when available, will be sent to the members of both bodies.

Trade Marks in Egypt.—We are informed by a firm of patent and trade mark attorneys in Cairo that the term "Registered Trade Mark" must not be used in Egypt except in connection with trade marks registered in Egypt under the new Trade Marks Law of 1939. Registration effected abroad will not justify the use of such a term nor will the fact that a trade mark has already been deposited with the Bureau of the Mixed Court of Appeal be a legal defence of such use. Section 34 of the Law prescribes a penalty of imprisonment for a term not exceeding one year and a fine not exceeding one hundred Egyptian pounds or one of these penalties for wrongfully indicating on trade marks or on business papers that a trade mark has been registered. The official notice requests that traders, manufacturers and importers should abstain from offering for sale goods bearing trade marks wrongfully indicating that such trade marks are registered and intimates that instructions have been given to the Inspectors of the Department of Commercial Legislation and Industrial Property to institute legal proceedings against anyone so offending the law.

Personal and Business

Crypto Equipment, Ltd., informs us that as from Monday, October 14th, its works address has been St. Mary's Street, Bridgwater, Somerset.

A Change of Name.—The name of the Jarrow Shipbreaking Company, Ltd., has been changed to Jarrow Engineering and Shipbreaking Company, Ltd.

Higgs Motors informs us that its London office has been transferred from Southampton Street, W.C.2, to 6, Coppice Walk, Totteridge, London, N.20. Telephone, Hillside 4497.

The Institution of Heating and Ventilating Engineers advises us that future communications should be addressed 21, Tothill Street, Westminster, S.W.1. Telephone, Whitehall 9609.

Modern Machine Tools Ltd. informs us that its works, showrooms and offices have been removed to more commodious premises on its Maudslay Road Works site, Coventry. Telephone number and telegraphic address remain the same.

The Late Mr. W. E. Hurford.—We regret to announce the death of Mr. W. E. Hurford, who was a member of the staff of Samuel Osborn and Co., Ltd., Sheffield, for over forty years. Mr. Hurford travelled extensively on behalf of his firm, and had many friends in this country and abroad.

An Appointment.—The Minister of Supply has appointed Mr. Thomas H. Summerson to the position of Director of Steel Castings. He is deputy managing director of Thomas Summerson and Sons, Ltd., of the Albert Hill Foundry. His father, Mr. R. B. Summerson, is chairman of the company, which celebrates its centenary this year.

A Presentation.—Mr. F. J. Pascoe, a director of British Timken, Ltd., Aston, Birmingham, recently made a presentation on behalf of the directors and staff to Mr. J. H. Boden, who has retired owing to ill-health. Mr. Boden has been with the British Timken organisation at Birmingham for twenty-five years. He was the company's first industrial sales representative.

Mr. Vernon L. Farthing, A.M.I. Mech. E., M.I. Mar. E., M. Inst. Pet., practising as a Consulting Engineer at Tower Buildings, Liverpool, has accepted an appointment with the Ministry of Supply, and has been posted as North-Western Area Officer, War Office Inspection Dept., with offices at Manchester. Mr. Frank Booth, Mr. Farthing's assistant, is carrying on the practice. The engineering agency business of Messrs. V. L. Farthing & Co. is also being looked after by Mr. Booth with an augmented staff. Mr. Farthing acted as Hon. Secretary of the Liverpool Engineering Society, which position he resigned on taking up his new appointment.

Railway Appointments.—Mr. A. B. Chester, divisional engineer, Central Division, Southern Railway, has been appointed general assistant to the Chief Engineer. In 1911 he joined the former London and South-Western Railway as an assistat, first on new works and then on design in the head office at Waterloo. He enlisted in 1914, and returned to the railway world on demobilisation.—Mr. W. A. Foster Graham has been appointed deputy traffic manager of the Great Northern Railway Company (Ireland). He began his career in the secretary's office of the company in 1912, and was confidential clerk to the secretary and assistant general manager from 1919 to 1926, and gained much valuable experience in collecting information for the Standing Committee of General Managers of the Irish Railways which was set up in 1920.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Illuminating Engineering Society

Tuesday, October 22nd.—E.L.M.A. Lighting Service Bureau, 2, Savoy Hill, W.C.2. "Industrial Lighting in War Time," H. C. Weston. 2.30 p.m.

Institution of Automobile Engineers

Tuesday, October 22nd.—Birmingham Centre: James Watt Memorial Institute, Great Charles Street, Birmingham. "Bearing Metals and their Suitability for Modern Requirements." M. Melhuish. 7 p.m.

Institution of Electrical Engineers

Monday, October 21st.—N.E. Centre: Newe House, Pilgrim Street, Newcastle-upon-Tyne. Chairman's Address, W. A. A. Burgess. 5.45 p.m.

Wednesday, October 23rd.—S. Midland Students: James Watt Memorial Inst., Great Charles Street, Birmingham. "Continuity of Supply," D. H. Ray. 6.30 p.m.

Thursday, October 24th.—Savoy Place, Victoria Embankment, W.C.2. Presidential Address, J. R. Beard. 2.30 p.m.

Institution of Mechanical Engineers

To-day, October 18th.—Storey's Gate, Westminster, S.W.1. Presidential address, "Mainly the Port of London," Asa Binns. 2.30 p.m.

Friday, October 25th.—Storey's Gate, Westminster, S.W.1. "The Desirability of Acceptance Test Charts for Machine Tools." 2.30 p.m.

Institution of Structural Engineers

Saturday, October 26th.—Yorkshire Branch: Hotel Metropole, Leeds. "The Channel Tunnel," T. J. Gueritte. 2.30 p.m.

Saturday, October 26th.—Engineers' Club, Albert Square, Manchester. "Principles and Applications of Automatic Temperature Control," M. J. Gartside. 2.30 p.m.

North-East Coast Institution of Engineers and Shipbuilders

To-day, October 18th.—Literary and Philosophical Society, Newcastle-upon-Tyne. Presidential address, W. A. Woodeson. 6 p.m.

Wednesday, October 23rd.—Student Section: Bolbec Hall, Newcastle-upon-Tyne. Chairman's address, G. Wright. 6.45 p.m.